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AQUATIC AND WILDLIFE RESOURCES

DEPARTMENT OF AGRICULTURE

OCTOBER 1, 1984 - SEPTEMBER 30, 1985
FY 1985

Guam
Aquatic
and
Wildlife
Resources
Annual
Report
FY'85

ANNUAL REPORT
FISCAL YEAR 1985

GUAM
AQUATIC & WILDLIFE RESOURCES DIVISION
Harry T. Kami, Chief

DEPARTMENT OF AGRICULTURE
Elizabeth P. Torres, Director

Edited by:
Robert D. Anderson
Paul J. Conry
Michael E. Molina

PERIOD COVERED:
October 1, 1984 to September 30, 1985

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Robert D. Anderson, Assistant Chief

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The members of the Guam Fishing & Boating Association, the Marianas Fishing Derby Committee and the Manager of the Guam Fishermen's Coop for allowing fishery biologists to examine their fish.

All fishermen and fish weir operators who have cooperated with fishery data collection.

All farmers engaged in aquaculture who cooperated by providing information and harvest data.

All hunters who have cooperated with wildlife data collection by filling out and returning hunter questionnaires.

The Base Commanders of the U.S. Naval Magazine, Naval Facility, Naval Station, Naval Communications Station and the Andersen Air Force Base.

The Security Officers and their staffs at the U.S. Naval Magazine, Naval Station, Naval Communication Station, and Andersen Air Force Base.

The Commander of the Marianas Section, U.S. Coast Guard.

The members of both print and electronic media for their assistance with our conservation education program.

The Cushing Zoo for cooperating with the Division by caring for injured wildlife.

The personnel of the Naval Oceanographic Command Detachment, U.S. Naval Air Station, Guam, for providing weather data.

GUAM FISH AND WILDLIFE INVESTIGATIONS
PROJECT FW-2R-22
Federal Aid in Fish and Wildlife Restoration Acts

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-22
SUB-PROJECT NO.: C-1
JOB NO.: 1

JOB TITLE: Coordination of Guam's Fish and Wildlife Programs.

PERIOD COVERED: October 1, 1984 to September 30, 1985.

OBJECTIVES

To plan, coordinate, supervise, and administer all fish and wildlife restoration programs.

PROCEDURES

1. Supervise the planning and documentation of the Fish and Wildlife programs.
2. Administer all fiscal and budgetary matters and coordinate with the Central Accounting and Budget Office.
3. Administer all personnel matters including recruitment of off-island staff.
4. Represent the Division and Department of Agriculture in all matters pertaining to Fish and Wildlife Resources.

RESULTS

The Division Chief and his staff were involved in preparing required documentation for the DJ-PR funded Guam Fish and Wildlife Investigation Program (FW-2R) and the Guam Endangered Species Program (E-1) funded under a Section 6 Cooperative Agreement. Documentation included various Project Agreement and AFA amendments, a new 5-year AFA for the Section 6 program, and the Project Agreement for Segment 23.

Fiscal and budgetary activities included monthly preparation and submission of reimbursement vouchers for our various Federal Aid programs and coordination with the Government Accounting and Budget Offices to ensure fiscal integrity.

The Division Chief and his staff represented the Division and the Department of Agriculture in all matters relating to fish and wildlife resources.

Division staff made a number of off-island trips related to Federal Aid programs. Wildlife Biologist Robert Beck escorted a shipment of Guam Rails and Micronesian Kingfishers to the Philadelphia Zoo in December, 1984, for later distribution to the various zoo's cooperating in the Division's captive breeding program. On this trip, Beck also visited the Bronx Zoo and the National Zoo's Conservation Research Center, and met with representatives of the various participating zoos in Washington, D.C.

Division Chief, Harry Kami and Wildlife Biologist Julie Savidge attended an avian disease workshop in Honolulu in December, 1984. Savidge also attended a two-week avian blood parasite workshop in Gainesville, Florida in May 12985, where she received personalized training from Dr. E.C. Griener in conducting blood parasite analysis.

Fishery Biologists Michael Molina and Robert Rinehart attended a WESTPAC-FIN Technical Subcommittee meeting in Honolulu in April, 1985.

The Division hosted a number of off-island visitors during the year. Ernie Kosaka, William Kramer, John Engbring, Peter Stine and Andy Yuen, all of the U.S. Fish and Wildlife Service in Honolulu, visited at various times to work with Division staff on various projects, including endangered species recovery plans and environmental reviews.

Ed Eckhoff, the National Marine Fisheries Service/U.S. Fish and Wildlife Service Special Agent on Guam worked closely with Division staff. In conjunction with Mr. Eckhoff, Mr. Jim Bartee of the U.S. Fish and Wildlife Service, Mr. Gene Witham and Mr. Bill Dickensen of the National Marine Fisheries Service, visited Guam and held a workshop on federal fish and wildlife law enforcement for the Division's enforcement staff and officers of Guam's Customs and Quarantine Division. Lt. Richard Rendon of the U.S. Coast Guard also participated in the workshop. In addition to the workshop, the NMFS and FWS personnel also met with the Division's biological staff to discuss matters of mutual interest.

Dr. Thomas Fritts, Dr. Norman Scott, and Mr. Brian Smith, of the U.S. FWS Denver Wildlife Research Center spent several months on Guam working on brown tree snake biology and control in coordination with Division biologists.

Mr. Sam Marshall of the Bronx Zoo and Mr. Gary Michael of the Philadelphia Zoo, each spent several months on Guam studying Micronesian Kingfishers and Guam crows, respectively and assisting the Division in the capture of birds for captive breeding.

Other visitors during the year included Ms. Margie Falanruw from Yap and Dr. Roland Baker, author of The Avifauna of Micronesia.

A film crew with the BBC visited and was assisted in producing a film segment on brown tree snakes.

The Division experienced several staff changes during the year. Administrative Assistant Annie Bonds and Secretary-Typist Guadalupe Mafnas transferred to the Director's office. June Elibosang was hired as a replacement for Bonds. Biological Aid Colleen Kerns and Biologist I (Part-time) Tim Sherwood left during the year. Conservation Officers Joseph Benavente, Danny Wolford, and David Torres also left during the year.

Report prepared by Robert D. Anderson

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-22
SUB-PROJECT NO.: C-2
JOB NO.: 1

PROJECT TITLE: Technical Guidance to Projects Affecting Guam's Fish and Wildlife Resources.

JOB TITLE: Technical Guidance to Projects Affecting Guam's Fish and Wildlife Resources.

PERIOD COVERED: October 1, 1984 to September 30, 1985.

BACKGROUND

The rapid development of Guam's economy has placed increasing demands upon Guam's natural resources. A trend toward urbanization has brought growth in the construction of residential, recreational, commercial, military, industrial, and public utility facilities, all of which have some impact upon the environment. To help minimize long-term adverse impacts of such development, the Division of Aquatic and Wildlife Resources (DAWR) has taken an increasingly active role in the area of technical guidance. Recently, the DAWR's responsibilities in this area have been increasing rapidly because review is now legally required for many development plans, permit applications, and impact statements.

OBJECTIVES

1. To minimize adverse impact resulting from the construction of recreational, commercial, residential, industrial or public utility facilities.

2. Provide technical assistance to military and civil agencies relative to the management and protection of fish and wildlife resources.

FINDINGS

The staff of the Division has been actively involved in the technical guidance function during this segment. Numerous development plans, impact statements, and permit applications have been submitted to the Division for review. Field investigations and meetings with responsible agencies have been conducted in many cases as a part of the review process.

Various Division staff members actively serve as members of the following groups:

1. Cocos Lagoon Task Force
2. Region IX Regional Response Team - Oceania
3. Territorial Seashore Park Management Committee
4. Subdivision and Development Review Committee

Members of the Division have attended numerous meetings and hearings pertaining to the protection of Guam's natural resources and have actively consulted with various civil and military agencies on environmental matters. Division staff maintain close liaison with the Department of Land Management, Department of Parks and Recreation, Guam Bureau of Planning, Guam Environmental Protection Agency, U.S. Army Corps of Engineers (ACOE), the U.S. Fish and Wildlife Service, the National Marine Fisheries Service, the U.S. Navy, the U.S. Coast Guard, the U.S. Air Force regarding matters of environmental concern. In addition, staff members actively consulted with the numerous off-island visitors, representing various agencies and organizations, who visited during the segment.

Considerable public contact was maintained by Division staff during the reporting segment. In addition to occasional interviews on radio, television, and in newspaper, staff members participated in National Wildlife Week, Chamorro Week, Earth Week and Environmental Fair activities and gave talks to a number of civic groups, sportsmans clubs, and school and university classes.

Some specific Technical Assistance activities included:

1. The Division was represented on the Subdivision and Development Review Committee, which met bi-weekly to review applications for rezoning, variances, and various types of development. The Division's input at this level is very important in ensuring that the protection of Guam's fish and wildlife resources be considered in land use planning.

2. Division staff attended a workshop sponsored by the U.S. Fish and Wildlife Service on the Section 7 consultation process and made a presentation on Guam's endangered species problem at the workshop.

3. The Division provided technical assistance to Andersen Air Force Base regarding the problem of excluding deer from flightline areas. This assistance including providing advice, information, recommendations, and reviewing plans to construct a fence in the area.

4. The Division reviewed several proposed subdivision developments for potential impacts on endangered species. Because these projects were to be federally financed, the developers and the funding agency (Farmers Home Administration) were also referred to the U.S. Fish and Wildlife Service.

5. The Division responded to an inquiry from the New York Conservation Department regarding Diazonon-related wildlife mortality.

6. The Division reviewed plans for the acquisition and development of an aquaculture hatchery facility at Fadian Point and made recommendations.

7. The Division reviewed and commented upon proposed changes in the hunting regulations in the Commonwealth of the Northern Marianas at the request of CNMI biologists.

8. The Division reviewed and commented upon ACOE permit and SDRC application to install a floating dock in the Agana Boat Basin to service commercial tour boats.

9. The Division assisted in the preparation of several Agricultural Impact Statements which are required in cases involving the rezoning of lands zoned "A" (Agricultural). In cases where the proposed rezoning would have negative impacts on the conservation of wildlife resources recommendations were made to disapprove the proposed rezoning.

10. The Division reviewed and commented on several proposals to dispose of government land through sale or exchange and made appropriate recommendations for the conservation of wildlife resources.

11. The Division provided technical assistance and advice on the repair and reconstruction of an aquaculture pond in Merizo.

12. The Division reviewed and commented on the Environmental Impact Assessment and ACOE permit applications for the construction of a harbor of refuge for small boats.

13. The Division reviewed and commented on the proposal of the Dai Ichi Hotel to construct a walkway access to a dinner-cruise catamaran.

14. The Division prepared applications for the acquisition of several parcels of excess federal land for conservation purposes. These applications were submitted to the Bureau of Planning and to the Governor for submittal to the General Services Administration.

15. The Division provided technical advice to the Army Corps of Engineers on a proposal to introduce giant clams to Cocos Lagoon and the probable impact on shellfish resources.

16. The Division reviewed and commented upon an environmental assessment prepared by the Navy for the proposed construction of a LORAN-C station on Guam.

17. The Division provided technical assistance in assessing the damage caused by Typhoon Bill, particularly in regard to aquatic resources and wildlife habitat.

18. The Division responded to many requests for information on laws and regulations pertaining to fish, wildlife, endangered species, hunting and fishing.

19. The Division responded to many requests for information on native wildlife, particularly endangered species.

20. The Division reviewed and commented upon Navy plans to upgrade their hazardous waste facility.

21. The Division provided technical advice and assistance to the Governor's Office in the preparation of the Economic Rearmament Plan, particularly in regard to aquaculture and fisheries.

22. Division staff met periodically with supervisors of the Customs and Quarantine Division to discuss animal imports and endangered species questions.

23. Division staff provided technical assistance to the Attorney Generals Office regarding negotiation of a revised concurrent jurisdiction agreement with the Navy and Air Force, with particular emphasis upon the protection of fish and wildlife resources.

24. The Division provided technical assistance to the Department of Commerce regarding the economic feasibility of aquaculture on Guam.

25. The Division reviewed and commented upon the department of Parks and Recreation ACOE application to repair the Merizo boat launching ramp.

26. The Division provided technical assistance to the U.S. Fish and Wildlife Service through the preparation of draft recovery plans for endangered fruit bats and native forest birds.

27. The Division reviewed and commented upon the Navy's ACOE application to construct and install diving boards and swim platform at Sumay Cove, Naval Station.

28. The Division reviewed and commented upon several ACOE applications to dredge swimming areas in Tumon Bay.

29. The Division reviewed and commented upon the ACOE application for the construction of the Achang Bay Marina.

30. The Division answered numerous requests for information on hunting from both on and off-island individuals. Specific request included information on protective coloration, bow hunting, and laws and regulations.

31. The Division reviewed and commented upon the plans of the Dai-Ichi Hotel for beach restoration in Tumon Bay.

32. The Division re-reviewed and commented upon the EIS for the proposed Astumbo Subdivision.

33. At the request of the Governor, the Division prepared a federal grant application for Technical Assistance in assessing the feasibility of deer farming on Guam.

34. The Division answered an inquiry regarding the mercury content of billfish.

35. The Division answered several inquiries regarding the feasibility of establishing a snake skin industry on Guam.

36. The Division reviewed and commented upon the ACOE and SDRC applications for the construction of the proposed Turtle Cove Marina.

37. The Division reviewed and commented upon the application of the Government of Guam for the necessary permits and clearances to remove the abandoned sewer outfall Adelup Point.

38. The Division reviewed and commented upon the application of the Government of Guam for the necessary permit and clearances to dredge swimming areas at Adelup Point.

39. Division staff provided technical assistance to the Air Force on several occasions by identifying the remains of birds involved in collisions with aircraft.

40. The Division reviewed and commented on the latest version of the Army Corps of Engineers Agana River Flood Control Plan.

41. Division staff reviewed and commented upon two environmental assessments prepared by the Navy for installation of fiber-optic cables at Naval Communications Area Master Station.

42. The Division reviewed and commented upon an environmental assessment for the construction of a youth center in Mangilao.

43. Division staff prepared a revision to the hunting regulations, including the imposition of a two-year moratorium on hunting of Philippine Turtle Doves.

44. Division staff conducted site inspections and prepared comments on the illegal filling of an area in the Atantano wetland by a Navy contractor.

45. Division staff reviewed and commented upon draft management plans for the Navy's Ecological Reserves at Haputo and Orote Point.

46. Division staff reviewed and commented upon the environmental assessment for the proposed golf course expansion at Andersen Air Force Base.

47. The Division reviewed and commented upon an environmental assessment prepared by the Army Reserve regarding military exercises in the Dandan area.

48. Division staff provided technical assistance to numerous farmers and the Air Force regarding pig damage. Damage control permits were issued when warrented.

49. The Division reviewed and commented upon the application of the Government of Guam to install a barge offshore at Ipao as a swim platform.

50. The Division reviewed and commented upon the plans of the Government of Guam to construct a saltwater pool on the Paseo in Agana.

51. The Division reviewed the application by a landowner for the necessary permits and clearances to construct a wooden pier at Sella Bay.

52. The Division reviewed and commented upon the plans of the Air Force to install three groundwater monitoring wells.

53. Several Division staff reviewed manuscripts for other authors and for professional journals.

54. The Division reviewed and commented upon the proposed maintenance dredging of the seawater intake channel at the Tanguisson Power Plant.

55. Division staff provided technical assistance in developing a master permit system for aquaculture developments.

56. The Division reviewed and commented upon the plans of the Air Force to destroy some deactivated B-52 bombers with explosives.

57. The Division reviewed and commented on the environmental impact assessment prepared by the Air Force for the proposed clearing of vegetation near the flightline at Andersen Air Force Base. The Division also provided information to the U.S. Fish and Wildlife Service for the Section 7 review of this project.

58. The Division provided technical assistance to the South Pacific Commission by reviewing annual work plans providing information on fishing activity, and reviewing a Tuna/Billfish assessment.

59. The Division staff completed several species accounts for the Endangered Species Information System.

60. Division staff participated in the Sea Grant Summer Fisheries Workshop, making several presentations to the enrollees.

61. The Division participated in the Bureau of Planning's Land Use Task Force and provided input to the Task Force on land-use laws and regulations that affect fish and wildlife resources.

62. The Division provided technical assistance to the Attorney General's Office in identifying fish killed illegally with explosives, hair and other tissues from suspected deer and pig carcasses, and in interpreting the laws and regulations that apply to fish and wildlife resources.

63. Division staff attended hunter safety briefings at Andersen Air Force Base to provide pertinent information to hunters.

64. Division staff made presentations on fish and wildlife resources at meetings of numerous clubs and other organizations during the year.

65. Division staff prepared numerous press releases to keep the public informed of fish and wildlife issues including hunting seasons, laws and regulations, Portuguese men-of-war, etc.

66. The Division provided input to the Governor's Ad Hoc Committee on Development Controls regarding the Guam Costal Management Plan.

67. The Division provided information on illegal fish to the Pacific Sealink Program.

68. The Division provided technical assistance to the National Marine Fisheries Service in identifying a dead whale found on the beach in Agat.

69. The Division provided information to the Department of Commerce on offshore fisheries harvest and tuna.

70. The Division provided information to the Department of Labor regarding wage determination for a fish hatchery manager.

71. The Division provided information regarding the seasonal harvest of offshore fishes to the University of Guam Marine Laboratory.

72. Information on the offshore harvest of pelagic fishes was supplied to the Western Pacific Marine Fisheries Advisory Council.

73. Technical assistance was provided to the Marianas Fishing Derby.

74. Technical information on the state of Guam's fish and wildlife resources was provided to the Guam Environmental Protection Agency for their annual report.

75. The Division reviewed and commented upon an ACOE permit application for the installation of a fire fighting system at Cabras Island.

76. The Division reviewed and commented upon an illegal fill in the Talofofo River caused by an aquaculture development.

77. Technical assistance and logistical support was given to Dr. Thomas Fritts of the U.S. Fish and Wildlife Service and his staff, Mr. Sam Marshall of the Bronx Zoo, and Mr. Gary Michael of the Philadelphia Zoo, each of whom spent considerable time on Guam conducting studies in cooperation with Division staff.

78. The Division was involved in several meetings with the Department of Parks and Recreation, Commerce, Public Works, and the Port Authority of Guam to assess the public needs for boating access development.

79. The Division provided information to the Navy on the presence of certain poisonous plants on Guam at their request.

80. The Division worked closely with the Air Force and Fish and Wildlife Service in revising the exisiting Sikes Act Cooperative Agreement with Andersen Air Force Base.

81. The Division reviewed and commented on the proposed Andersen Air Force Base Hunting Regulations.

82. The Division provided technical assistance and to BBC film crew producing a documentary on endangered species with particular emphasis on the Guam Rail and brown tree snake.

83. The Division reviewed and commented upon a proposed golf driving range in Agana Swamp.

Report prepared by: Robert D. Anderson and Michael E. Molina

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-22
SUB-PROJECT NO.: C-3
JOB NO.: 1

SUB-PROJECT TITLE: Public Information and Education of Guam's Fish and Wildlife Restoration and Endangered Species Programs.

JOB TITLE: Public Information and Education

PERIOD COVERED: October 1, 1984 to September 30, 1985.

OBJECTIVES

To inform and educate the public of the need to conserve, restore, and wisely manage the island's fish and wildlife resources as it can be accomplished through the Division's Federal Aid Programs.

RESULTS

This job was inactive throughout this segment due to funding uncertainties and lack of manpower.

RECOMMENDATION

Activate this job during the next segment provided adequate funding and manpower are available.

Report prepared by Robert D. Anderson

GUAM FISHERIES INVESTIGATIONS
PROJECT FW-2R-22
Federal Aid in Sport Fish Restoration Act

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-22
SUB-PROJECT NO.: F
STUDY NO.: F-1
JOB NO.: 1

JOB TITLE: Offshore Fisheries Survey

PERIOD COVERED: October 1, 1984 to September 30, 1985.

SUMMARY

Monthly offshore fisheries surveys were conducted at the Agana Boat Basin and other boat launching locations along Guam's shoreline from October 1984 through September 1985. An island-wide finfish catch is estimated at 323.7 metric tons (m.t.) for that period. The bulk of the catch, 254.9 m.t., was harvested by trolling during an estimated 45,472 boat hrs. of effort. Bottomfishing produced an estimated 39.6 m.t., primarily deepwater snappers, followed by night-light jigging for atulai (18.5 m.t.) and spearfishing (9.7 m.t.). Approximately 1.0 m.t. were landed by longlining, spincasting, and gill netting. (Since the GOES does not take into consideration sample days in which a given method was known to occur but no interviews were obtained, catches by infrequently encountered methods may be under estimated as follows: night-light jigging for atulai (31%); spearfishing (24%); longlining (50%), and gill netting (50%).)

BACKGROUND

Effective management of the island's offshore fishery resources requires accumulating data on fishing pressure, types of fishing methods used and annual harvest. In order to identify trends in fishing participation, effort, and catch, the Division of Aquatic and Wildlife Resources (DAWR) has been monitoring offshore fishing activities for the past nine years. Over this period of time, survey and analysis methodologies have changed in response to fluctuations in budget and staff. Recently, however, major advances have been made in both field survey techniques and in the area of computerized statistical analysis. Much of this progress has resulted from the combined efforts of DAWR and National Marine Fisheries Service (NMFS) personnel through the Western Pacific Fisheries Information Network (WPACFIN) program (see Study F-1, Job 3).

PROCEDURES

During FY 85, interviews of returning offshore fishing parties were conducted on six randomly selected days per month at the Agana Boat Basin. In each month, four of these days were weekdays and two were holidays (which in this report includes weekend days). Each survey consisted of two periods, one from 0600 to 1000 hours and the other from 1500 to 2400 hours.

Returning fishers were asked standard questions regarding fishing methods, effort, catch, areas fished, etc. Questions were prioritized so that the most important information was

PROCEDURES

During FY 85, interviews of returning offshore fishing parties were conducted on six randomly selected days per month at the Agana Boat Basin. In each month, four of these days were weekdays and two were holidays (which in this report includes weekend days). Each survey consisted of two periods, one from 0600 to 1000 hours and the other from 1500 to 2400 hours.

Returning fishers were asked standard questions regarding fishing methods, effort, catch, areas fished, etc. Questions were prioritized so that the most important information was obtained for otherwise incomplete interviews. Although attempts were made to intercept all returning boats, and to examine all catches, this was not always feasible.

During an interview each fish in the catch was measured when there was enough time to do so. Otherwise, efforts were directed at taking unbiased subsamples and all unmeasured fishes of each species were counted. Batch weights of all measured, unweighed fishes were calculated by species from known length-weight relationships. If additional data were needed to determine a valid length-weight relationship for a particular species, individuals of this species were weighed as well as measured. If adequate data were unavailable for calculating the weight of measured fish, available data on the most morphologically similar species were used.

Estimates of the number of fishing boats returning to the boat basin outside of the survey period were made. This was done in order to calculate their contribution to the total offshore fishing activity that emanated from the boat basin on each survey day. This was also done separately for each fishing method encountered in order to eliminate any bias inherent in the sampling period. The following relationship was used in determining the P_1 values utilized by the GOES (see NOAA SWFC Admin. report H-83-21C):

$$P_1 = \frac{P(n/m)}{a}$$

where: a = estimated 24 hr. participation for a given day at the Agana Boat Basin.

p = no. of boats in which the fishing methods employed are known.

n = interview count for a given method.

m = no. of boats known to participate in a given method.

In addition, estimates of the number of active fishing boats not utilizing the boat basin on a given survey day were made. This was based on the numbers of empty trailers, berths, moorings, etc. counted at Merizo, Apra Harbor and other launch sites during inshore fishing participation surveys (see Study F-1, Job 2).

All data collected during FY 85 were entered into computerized files and expanded utilizing a program based on modifications of the algorithms outlined in the National Marine Fisheries Service Administrative Report H-83-21C (see Study F-1, Job 3). Since it was possible to obtain only an instantaneous estimate of offshore participation at launch points other than the Agana Boat Basin, a 24-hour island-wide participation estimate was made utilizing the hypothetical relationship:

$$I_p = \frac{A_t}{A_i} \times I_i + A_p$$

Where I_p = estimated island-wide 24-hr. participation for a given day.

I_i = instantaneous island-wide counts for that day.

A_t = estimated mean 24 hr. participation at Agana Boat Basin.

A_i = mean daily instantaneous participation counts at the Agana Boat Basin.

A_p = estimated 24 hr. participation for a given day at the Agana Boat Basin.

The portion (P_2) of the 24-hour island-wide participation estimate of boats that fished out of the Agana Boat Basin can be obtained by the following equation:

$$P_2 = \frac{A_p}{I_p}$$

This was done separately on data obtained during weekday and holiday survey days.

The island-wide expansion of data is based on catch rates obtained solely from information collected at the Agana Boat Basin. An expansion was done for each month and for the FY 85 year as a whole by applying the raw data to the Guam Offshore Expansion System (GOES; See Study F-1, Job 3). The output of each monthly expansion includes standard errors (SE) and 90% confidence limits (CL) for participation, effort and harvest estimates. The sums of these estimates for all months were used to derive supplemental annual estimates, although calculations of SE and 90% CL for the year were not possible by this method. In contrast, annual estimates, including SE and 90% CL were computed by the GOES for a sample size of 48 days.

Results of the Guam International Fishing Derby (GIFD) are included in the August and annual estimates. This was done by the GOES tournament utility which adds GIFD data directly to a 28 day August expansion and 362 day annual expansion. We consider this legitimate since the trolling effect during the GIFD is abnormally high and represents nearly all of the island-wide fishing effort for that three day period.

Since different calculations result in different rounding errors, slightly different annual estimates are produced by the two methods. For each of the fishing methods that were analyzed, various catch rates were calculated and these included kilograms (Kg) harvested per boat-trip (B-T), boat-hour (B-H), and person-hour (P-H) of effort.

Since the GOES can not expand for days in which there was participation for a given method but no interviews were obtained for that method, it under-estimates methods which are rarely encountered during the sample period. For this reason the following correction factor was used to estimate the degree of undersampling reflected in the GOES annual estimates.

$$F = \frac{(f_{wd} \times \text{no. of WD days}) + (f_{we} \times \text{no. of WE days})}{365}$$

where F = correction factor by which the GOES harvest is multiplied.

$f = \frac{x}{y}$

x = the sum of boats known to participate in a given method for all days in which that method occurred.

y = the sum of boats known to participate in a given method during days in which an interview was obtained.

RESULTS

Trolling

Estimated monthly and annual trolling participation, effort and harvest which occurred during FY 85 are given in Table 1. An estimated 254.9 m.t. of troll-caught fish were landed island-wide during FY 85. Monthly catches ranged from a high of 31.3 m.t. in December to a low of 7.2 m.t. in November (Figure 1). An estimated 45,472 boat-hours were spent trolling with an average catch rate of 5.61 kg/boat-hour. Monthly catch rates (CPUE) ranged from 7.6 kg/boat-hour in September to 3.5 kg/boat-hour in March.

The usual five pelagic species accounted for the bulk of the catch (96.2%; Table 2). Skipjack tuna *(Katsuwonus pelamis*; 24.6%) was the most important species, followed by wahoo *(Acanthocybium solandri*; 21.5%); mahimahi *(Coryphaena hippurus*, 18.5%); yellowfin tuna *(Thunnus albacares*; 18.9%), and blue marlin *(Makaira nigricans*; 12.7%). Scombrids collectively comprised 66.4% of the total trolling harvest.

As in previous years, the FY 85 trolling harvest was atypical in several respects. The mahimahi catch doubled over the unusually low catch of FY 84, but was still well below the historical mean of 29 m.t. The wahoo catch more than doubled over that of last year, rebounding to exceed the historically high catches of FY 82-83. The skipjack tuna catch was less than half that of the previous year while catches of yellowfin tuna, blue marlin and barracuda remained at about the same as those of the previous year. The overall poor catches of mahimahi and particularly skipjack tuna contributed to a drop in the CPUE from 6.5 kg/boat-hour in FY 84 to under 5.8 kg/boat-hour in FY 85. However, the estimated catch for the year was slightly higher in FY 85 (255 vs. 233 m.t. in FY 84). This was due to a 24% increase in the overall effort to a historical high of 45, 269 boat-hours.*

Bottomfishing

The estimated monthly and annual bottomfishing participation, effort, and harvest which occurred during FY 85 is shown in Table 3. An estimated 39.6 m.t. of bottomfish were harvested island-wide. Monthly catches ranged from a high of 6.1 m.t. in July to a low of 0.4 m.t. in January. In general, the largest monthly catches occurred from April through September (Figure 1). An estimated 14,084 boat-hours were spent bottomfishing,

*While there is little doubt that participation and effort has increased over the years, improved censusing procedures inititated in FY 85 have indicated that estimates of participation from FY 84 to at least as far back as FY 81 were probably underestimated.

Table 1. Estimated monthly and annual trolling participation, effort and harvest during FY 85. Estimates include the GIFD.

A) PARTICIPATION:

MONTH	NO. OF PERSONS	SE	90% CL	NO. OF BOAT-TRIPS	SE	90% CL
OCT	1521.7	243.3	518.7	568.1	126.7	270.0
NOV	953.6	156.0	332.7	344.4	47.1	100.0
DEC	2546.5	274.5	585.3	1056.3	60.6	129.2
JAN	2059.9	585.0	1247.3	575.1	116.3	247.9
FEB	1824.4	424.5	905.1	671.9	132.8	283.2
MAR	3026.8	675.3	1439.8	784.2	132.2	281.8
APR	1967.1	316.2	674.2	766.9	160.6	342.4
MAY	1880.8	256.7	547.2	848.8	107.3	228.8
JUN	1860.7	339.3	723.3	729.8	106.5	227.1
JUL	2584.7	326.3	695.7	937.0	118.2	252.1
AUG	2192.1	402.5	858.0	789.8	127.2	271.2
SEP	2489.5	265.7	625.1	864.3	130.7	307.5
TOTAL	24907.8			8936.6		
GOES	24991.4	1497.8	2522.2	8956.4	470.5	792.4

B) EFFORT:

MONTH	NO. OF PERSON-HOURS	SE	90% CL	NO. OF BOAT-HOURS	SE	90% CL
OCT	6908.8	1375.9	2933.5	2622.1	706.2	1505.6
NOV	3075.5	653.8	1393.9	1052.0	172.8	368.3
DEC	13937.8	1058.6	2256.9	5929.0	546.8	1165.9
JAN	10044.9	2351.7	5013.9	3222.4	802.6	1711.1
FEB	12095.2	2802.3	5974.6	4644.6	1045.9	2229.8
MAR	12189.5	2625.8	5598.2	3425.8	631.4	1346.0
APR	10581.9	1780.0	3794.9	4108.6	893.0	1903.9
MAY	9866.7	1268.0	2703.3	4502.5	654.3	1203.1
JUN	8880.6	1575.7	3359.5	3513.1	583.5	1244.1
JUL	10856.1	1415.2	3017.2	3975.7	582.4	1241.8
AUG	13094.4	2295.2	4893.4	4557.0	730.7	1557.8
SEP	10317.1	2220.6	5225.1	3716.8	931.7	2192.4
TOTAL	121848.5			45269.6		
GOES	122632.3	7305.1	12301.8	45472.4	2782.1	4685.0

C) HARVEST:

MONTH	NO. OF KILOGRAMS	SE	90% CL	Kg/B-T	Kg/B-H	Kg/P-H
OCT	9372.7	5068.5	10806.1	16.5	3.6	1.4
NOV	7168.1	2417.4	5153.8	20.8	5.8	2.3
DEC	31325.4	3316.9	7071.5	29.7	5.3	2.2
JAN	16802.4	7189.4	15327.7	29.2	5.2	1.6
FEB	22755.9	7561.2	16120.4	33.9	4.9	1.9
MAR	11874.6	2983.2	6360.2	15.1	3.5	1.0
APR	24456.6	6827.5	14556.3	31.9	6.0	2.3
MAY	28154.1	6318.5	13471.0	33.2	6.3	2.9
JUN	20461.7	8066.6	17198.1	28.0	5.8	2.3
JUL	23314.1	6865.6	14637.4	24.9	5.9	2.1
AUG	29413.0	3448.3	7351.7	37.2	6.5	2.2
SEP	28259.5	11579.3	27246.1	32.7	7.6	2.7
TOTAL	253358.1			28.4	5.6	2.1
GOES	254886.2	22991.7	38718.0	28.5	5.6	2.1

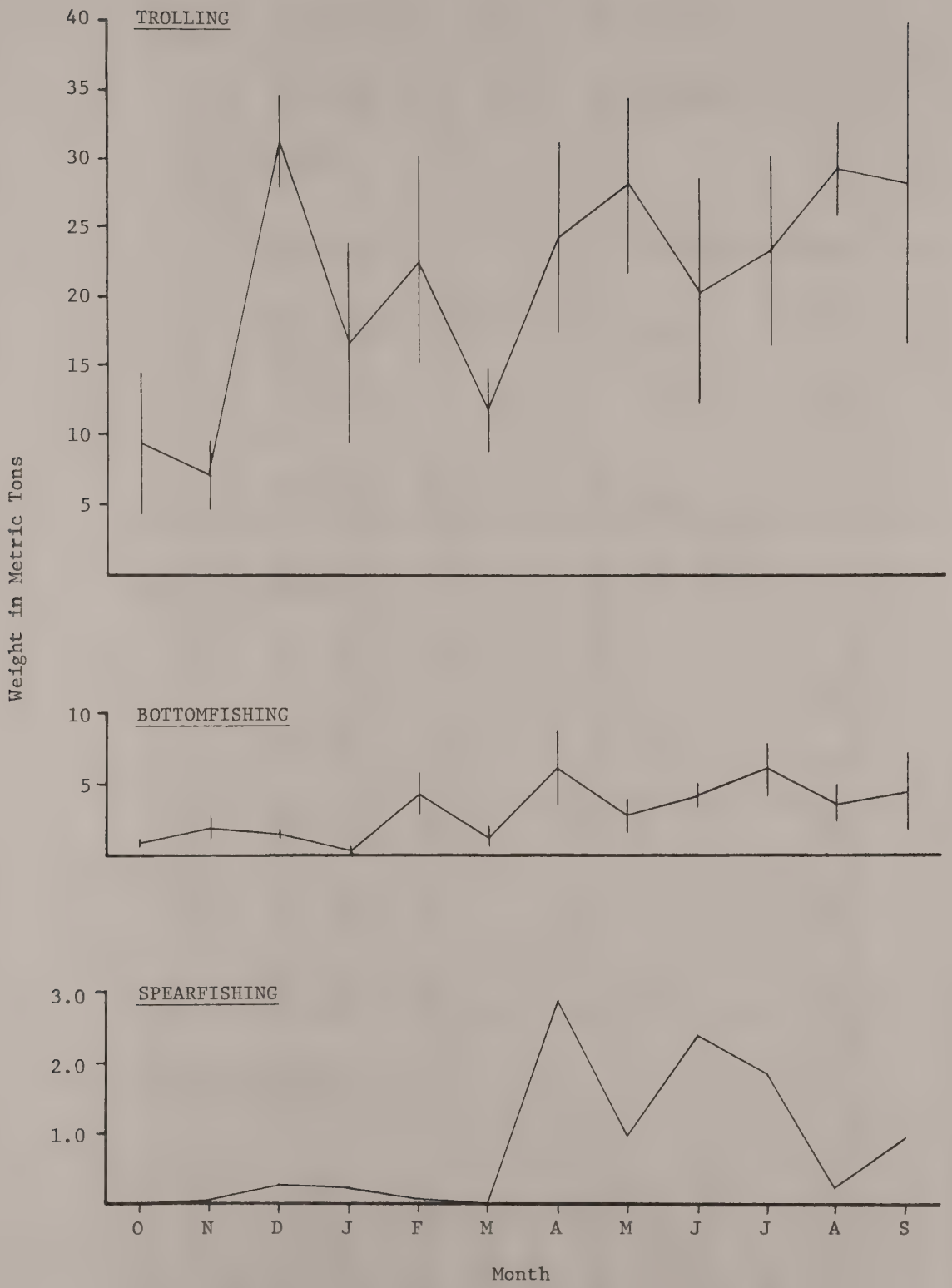

Figure 1. Monthly fluctuations in the estimated Guam offshore fish harvests during FY 85. The trolling estimate includes the GIFD. Vertical lines denote the standard error (not available for spearfishing).

Table 2. Monthly and annual composition of the Guam trolling harvest during FY 85. Estimated weights are in metric tons. The GIFD catch is included.

FAMILY AND SPECIES	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOTAL	% TOTAL
Belonidae														
Strongylura incisa										13.8			13.8	<0.1
Carangidae														
Carangoides orthogrammus							21.7						21.7	<0.1
Caranx ignobilis							414.4						414.4	0.2
C. melampygus				5.0	61.9			140.3	193.5	219.7	15.7		636.1	0.3
C. sexfasciatus								42.2					42.2	<0.1
Elagatis bipinnulatus		101.1			38.2		33.2	225.7	8.6	159.8	109.8		676.4	0.3
Scomberoides lysan				2.5						49.6			52.1	<0.1
Coryphaenidae														
Coryphaena hippurus			6031.1	7474.9	13071.1	8013.4	10000.1	1601.0		283.7	375.6	39.7	46890.6	18.5
Bramidae														
Brama myersi											4.0		4.0	<0.1
Lutjanidae														
Aphareus furcatus												4.9	4.9	<0.1
Aprion virescens					143.7								143.7	0.1
Sphyraenidae														
Sphyraena barracuda		22.4	612.8	89.9	89.7	167.5	381.3	561.9	940.7	334.7	157.8	94.0	3452.7	1.4
S. genie								316.4					316.4	.1
Sphyraena spp.												220.4	220.4	.1
Scombridae														
Acanthocybium solandri	1401.3	4475.3	15508.8	2077.2	5721.5	1262.3	6253.1	2029.2	782.6	1406.3	7408.7	6085.0	54411.3	21.5
Euthynnus affinis	7.6	51.7	241.2		91.4	18.3	29.8			323.7		15.4	779.1	0.3
Grammatorcynos bilineatus												4.4	4.4	<0.1
Gymnosarda unicolor				62.4	740.6		773.1	164.5	618.1	141.2	198.8	84.4	2783.1	1.1
Katsuwonus pelamis	5311.7	2333.3	3072.4	2763.8	1403.8	1510.7	4517.4	13450.1	10327.2	3782.4	7717.4	6180.5	62370.7	24.6
Thunnus albacares	1098.2	184.4	2698.0	4326.7	1393.8	338.1	1324.6	8420.4	4501.7	8633.6	7728.4	7181.2	47829.1	18.9
Istiophoridae														
Makaira nigricans	1553.9		3161.1			564.5	707.9	1202.3	3089.3	7965.6	5696.8	8349.4	32290.8	12.7
TOTAL	9372.7	7168.1	31325.4	16802.4	22755.9	11874.6	24456.6	28154.1	20461.7	23314.1	29413.0	28259.5	253358.1	100.1

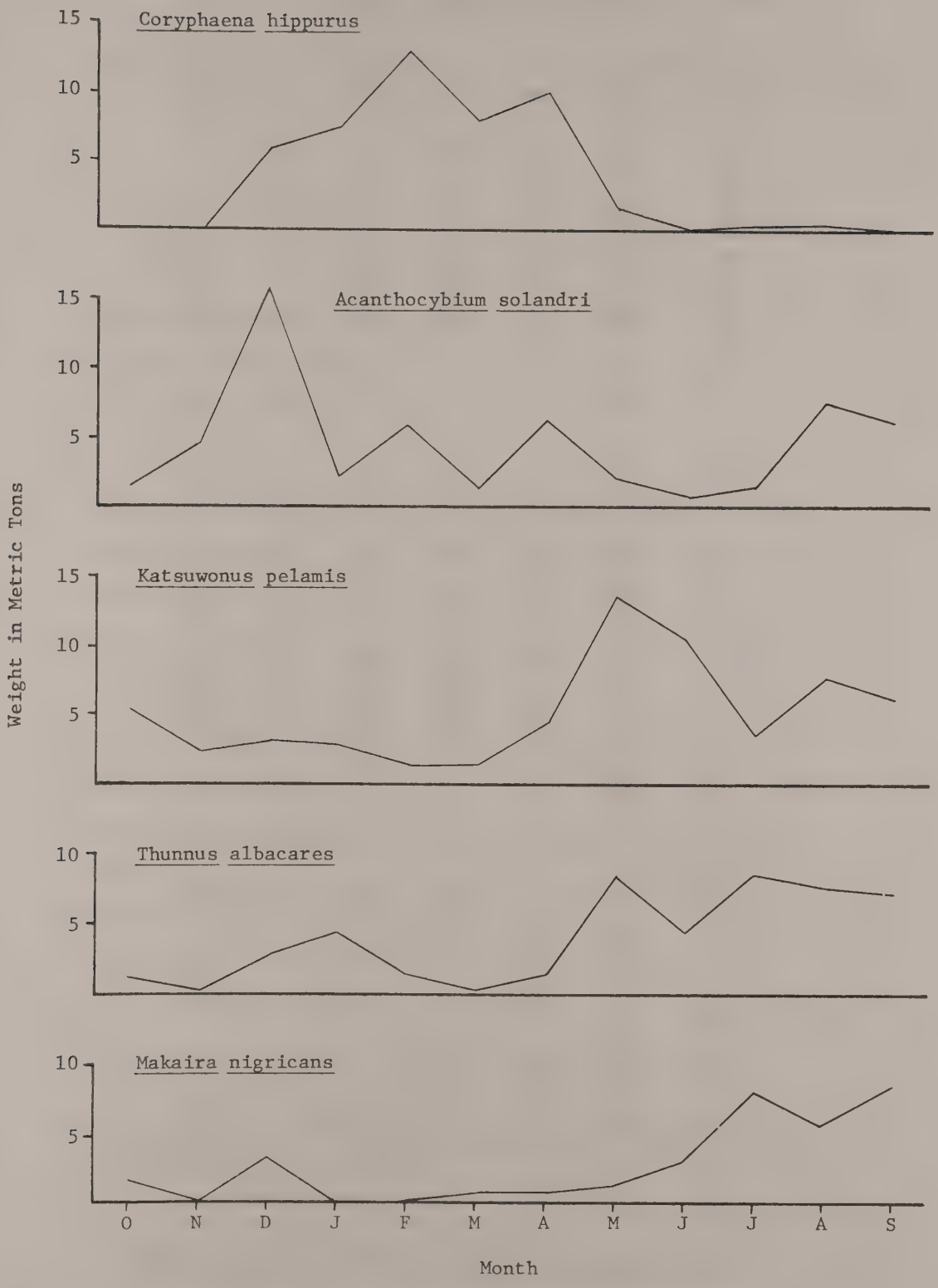

Figure 2. Monthly fluctuations in the estimated harvest of Guam's major troll-caught species during FY 85. Estimates include the GIFD.

Table 3. Estimated monthly and annual Guam bottomfishing participation, effort and harvest during FY 85. See text for explanation.

A) PARTICIPATION:

MONTH	NO. OF PERSONS	SE	90% CL	NO. OF BOAT-TRIPS	SE	90% CL
OCT	362.4	173.1	369.1	145.3	67.5	143.9
NOV	246.1	78.8	167.9	92.6	26.7	56.9
DEC	324.4	126.9	270.6	147.8	35.8	76.4
JAN	387.7	226.8	483.5	106.5	57.3	122.1
FEB	1045.5	183.0	390.1	358.7	92.3	196.9
MAR	658..3	225.6	481.0	216.0	45.2	96.4
APR	816.2	209.6	446.9	322.9	84.4	180.0
MAY	568.1	207.5	442.5	229.3	75.8	161.6
JUN	1084.2	253.0	539.3	412.4	69.2	147.6
JUL	1081.8	276.8	590.1	408.4	99.7	212.6
AUG*	868.8	309.8	660.4	340.6	104.9	223.7
SEP	791.3	128.2	301.6	324.7	67.9	159.7
TOTAL	8234.8			3105.2		
GOES**	8412.0	813.7	1370.2	3153.7	284.7	479.4

B) EFFORT:

MONTH	NO. OF PERSON-HOURS	SE	90% CL	NO. OF BOAT-HOURS	SE	90% CL
OCT	793.8	395.0	842.1	318.1	156.3	333.2
NOV	1274.3	494.8	1054.9	466.9	186.3	397.2
DEC	1065.9	395.8	843.9	463.1	111.8	238.3
JUL	1250.7	828.2	1765.7	350.9	213.3	454.8
FEB	4999.3	803.3	1172.6	1607.9	229.6	489.6
MAR	1904.3	252.9	539.1	686.4	145.3	309.8
APR	5281.8	2698.1	5752.4	2114.8	1115.5	2378.3
MAY	3259.4	1094.1	2332.7	1453.9	540.6	1152.6
JUN	4730.1	860.3	1834.2	1805.9	236.4	503.9
JUL	5157.6	1616.7	3446.9	1917.3	578.4	1233.1
AUG	4091.2	1763.3	3759.4	1544.5	594.6	1267.7
SEP	3080.0	638.0	1501.3	1354.6	341.3	803.0
TOTAL	36888.4			14084.3		
GOES	37929.6	4646.0	7823.9	14356.4	1723.7	2902.7

C) HARVEST:

MONTH	NO. OF KILOGRAMS	SE	90% CL	Kg/B-T	Kg/B-H	Kg/P-H
OCT	658.0	443.7	946.0	4.5	2.1	.8
NOV	1887.5	890.6	1898.7	20.4	4.0	1.5
DEC	1616.2	289.9	618.1	10.9	3.5	1.5
JAN	338.3	218.2	465.1	3.2	1.0	.3
FEB	4314.7	1467.6	3128.9	12.0	2.7	.9
MAR	1155.1	836.3	1782.9	5.3	1.7	.6
APR	6222.0	2633.9	5615.5	19.3	2.9	1.2
MAY	2708.2	1190.5	2538.2	11.8	1.9	.8
JUN	4168.5	982.2	2094.0	10.1	2.3	.9
JUL	6110.9	1686.8	3596.2	15.0	3.2	1.2
AUG	3822.9	1327.5	2830.2	11.2	2.5	.9
SEP	5594.9	2699.5	6351.9	17.2	4.1	1.8
TOTAL	38597.2			12.4	2.7	1.0
GOES	39591.9	5474.0	9218.1	12.0	2.8	1.0

*Results are based on a 28 day expansion on the assumption that bottomfishing was negligible during the three day GIFD.

**Results are based on a 362 day expansion based on the assumption that bottomfishing was negligible during the three day GIFD.

Table 4. Composition of the Guam bottomfishing harvest during FY 85. Estimated weights are in metric tons. Percentages are based on the differential portion of the catch only.

FAMILY	WEGHT (Kg)	%
Carcharhinidae (Requiem sharks)	693.3	2.5
Holocentridae (Squirrelfishes)	915.4	3.3
Serranidae (Groupers)	3,093.8	11.1
Carangidae (Jack)	1,580.1	5.6
Lutjanidae (Snappers)	7,701.0	27.5
Lethrinidae (Emperors)	12,302.1	44.0
Mullidae (Goatfishes)	642.9	2.3
Sphyraenidae (Barracudas)	44.4	0.2
Labridae (Wrasses)	161.3	0.6
Scombridae (Tunas)	293.0	1.0
Balistidae (Triggerfishes)	411.6	1.5
Triodontidae (Pelagic puffer)	28.4	0.1
*Others	120.8	0.4
SUBTOTAL	27,988.1	100.1
Undifferentiated	10,607.6	
TOTAL	38,595.7	

*Includes *Dasyatidae, Synodontidae, Priacanthidae, Apogonidae, Malacanthidae, Caesionidae, Haemulidae, Cirrhitidae, Scaridae,* and *Acanthuridae,* each of which comprised less than 0.1% of the catch.

resulting in an overall catch rate of 2.8 kg/boat-hour. Monthly catch rates ranged from 1.0 kg/boat-hour in January to 4.1 kg/boat-hour in September.

As usual, emperors (Lethrinidae) and snappers (Lutjanidae) were the most important bottomfish families, collectively comprising 71.5% of the catch (Table 4). FY 85, however, was the first year in which the catch of emperors (44.0%) exceeded that of snappers (27.5%). By far the most important species was the redgilled mafute *(Lethrinus rubicoperculatus;* 9.5 m.t.) which accounted for an estimated 33.9% of the overall bottomfishing catch. Deepwater species *(Etelis spp., Pristipomoides spp.)* comprised the bulk of the snapper catch (67.6%). The four most important species of snapper were the yellowtail kalikali *(P. auricilla),* followed by onaga *(E. coruscans),* gindai *(P. zonatus),* and silver-mouth *(Aphareus rutilans).* Uku *(Aprion virescens)* comprised nearly half of the shallow-water snapper catch. Other important families included the Serranidae (groupers; 11.1%) Carangidae (5.6%), Holocentridae (3.3%), Mullidae (2.3%) and Balistidae (1.5%) which were landed primarily at relatively shallow depths.

Spearfishing

The estimated monthly and annual participation, effort, and harvest for spearfishing from boats during FY 85 is summarized in Tables 5 and 6. (Readers should also refer to study F-1, Job 2 for estimates of spearing from shore, i.e., without the use of boats, to gain a more complete picture of FY 84 spearfishing activities on Guam.)

An estimated 9.7 m.t. of speared fish, crustaceans, and octopuses were landed from boats during FY 85. Approximately 4.7 m.t. were taken by snorkelers and 4.9 m.t. were harvested by SCUBA divers. An estimated 1,532 boat-hours of fishing effort were expended by spearfishers (608 boat-hours by snorkelers and 904 boat-hours by SCUBA divers). The average catch rate for spearfishing was approximately 6.3 kg/boat-hour. Since some spearfishing parties return late at night outside our survey period and the GOES only considered complete interviews, we believe that the above estimates are low. Based on days in which participation in spearfishing occurred, but interviews were not obtained, it is believed that the GOES expansion for FY 85 is an underestimate of the spearfishing catch by 24%.

Parrotfishes (Scaridae; 44.1%) clearly dominated the FY 85 spearfishing catch (Table 7). Surgeonfishes (Acanthuridae; 23.0%) were a distant second, followed by rudderfishes (Kyphosidae; 5.3%), groupers (Serranidae; 7.6%), wrasses (Labridae; 5.0%), squirrelfishes (Holocentridae; 4.1%) and mullet (Mugilidae; 3.9%). The remaining fish families collectively accounted for less than 7% (0.4 m.t.) of the catch. In addition to fishes, an estimated 0.6 m.t. (5.7%) of crustaceans (primarily spiny lobsters) and octopuses were harvested during FY 85.

Atulai Night-Light Jigging

In the past it has not been possible to obtain a reasonable estimate for atulai night-light jigging since most parties return in the early morning hours outside the census period. For this reason changes in sampling period and method of determining participation were implemented in FY 85 which made it possible to account for the bulk of offshore atulai fishing for the first time.

Atulai fishing was encountered in October and November 1984 and from May to September, 1985 but interviews could not be obtained in November and September. An estimated 18.5 m.t. of atulai were landed by night-light jigging from boats during FY 85. This catch resulted from an estimated 4,336 boat-hours of fishing effort at an average catch

Table 5. Estimated monthly and annual Guam offshore spearfishing (all methods) participation, effort and harvest during FY 85. See text for explanation.

MONTH	PARTICIPATION NO. Of PERSONS	PARTICIPATION NO. OF BOAT-TRIPS	EFFORT NO. OF PERSON-HRS.	EFFORT NO. OF BOAT-HRS.	HARVEST NO. OF KILOGRAMS	HARVEST Kg/B-T	HARVEST Kg-B-H	HARVEST Kg/P-H
OCT								
NOV	49.8	25.0	57.4	28.7	22.2	.8	.9	.4
DEC	20.6	20.6	61.9	61.9	280.6	13.6	4.5	4.5
JAN	57.4	19.1	344.2	114.7	225.3	11.8	2.0	.7
FEB	43.2	21.6	86.4	43.2	79.9	3.7	1.8	.9
MAR								
APR	152.6	66.0	405.3	174.2	2899.8	43.9	16.6	7.2
MAY	236.4	84.3	363.6	156.0	961.0	11.4	6.2	2.6
JUN	620.7	216.2	1440.9	456.8	2399.3	11.1	5.3	1.7
JUL	219.1	99.9	559.5	271.8	1841.8	18.4	6.8	3.3
AUG	48.6	32.4	83.7	55.8	231.0	7.1	4.1	2.8
SEP	208.5	75.9	556.3	194.4	862.5	11.4	4.4	1.6
TOTAL	1656.9	661.0	3959.2	1557.5	9803.4	14.8	6.3	2.5
GOES	1637.9	651.8	3919.7	1532.4	9683.8	14.9	6.3	2.5

Table 6. Estimated annual Guam offshore spearfishing participation, effort and harvest by method during FY 85. See text for explanation.

A) PARTICIPATION

	NO. OF PERSONS	SE	90% CL	NO. OF BOAT-TRIPS	SE	90% CL
Snorkel	593.9	147.2	247.8	179.4	49.5	83.4
Scuba	993.7	233.1	392.5	462.3	95.1	160.1
Unknown or both	50.7	45.7	76.9	10.1	9.1	15.4
Total Spearfishing	1637.9			651.8		

B) EFFORT

	PERSON-HOURS	SE	90% CL	BOAT-HOURS	CE	90% CL
Snorkel	2028.2	611.7	1030.1	608.0	184.7	311.0
Scuba	1790.1	416.6	701.5	904.1	183.6	309.3
Unknown or both	101.4	91.3	153.8	20.3	18.3	30.8
Total Spearfishing	3919.4			1532.4		

C) HARVEST

	NO. OF KILOGRAMS	SE	90% CL	Kg/B-T	Kg/B-H	Kg/P-H
Snorkel	4742.0	2160.7	3638.7	26.4	7.8	2.3
Scuba	4916.0	1286.1	2165.7	10.6	5.4	2.7
Unknown or both	25.8	23.2	39.1	2.6	1.3	.3
Total Spearfishing	9683.8			14.9	6.3	2.5

Table 7. Composition of the Guam spearfishing harvest during FY 85. Percentages of finfish are of the differentiated portion of the finfish catch only.

FAMILY	SNORKEL (Kg)	%	SCUBA (Kg)	%	UNKNOWN OR MIXED (Kg)	%	TOTAL (Kg)	%
Exocoetidae (Flying Fishes)			1.4	<.1			1.4	<.1
Holocentridae (Squirrelfishes)	23.3	1.4	207.0	5.2	1.4	7.0	231.7	4.1
Scorpaenidae (Scorpionfishes)	23.2	1.4					23.2	0.4
Serranidae (Groupers)	48.2	3.0	373.3	9.4	4.0	20.0	425.5	7.6
Priacanthidae (Bigeyes)			4.3	0.1			4.3	.1
Carangidae (Jacks)	79.6	4.9					79.6	1.4
Lutjanidae (Snappers)			48.5	1.2			48.5	0.9
Caesionidae (Fusiliers)			10.4	0.3			10.4	0.2
Haemulidae (Sweetlips)			47.1	1.2			47.1	.8
Lethrinidae (Emperors)			27.0	0.7			27.0	.5
Mullidae (Goatfishes)	10.5	0.6	29.6	0.7			40.1	.7
Kyphosidae (Rudderfishes)	254.5	15.7	39.2	1.0			293.7	5.3
Ephipidae (Batfishes)			24.7	0.6			24.7	.4
Pomacanthidae (Angelfishes)	2.3	0.1					2.3	<.1
Mugilidae (Mullet)	220.3	13.6					220.3	3.9
Labridae (Wrasses)	16.3	1.0	264.5	6.7			280.8	5.0
Scaridae (Parrotfishes)	623.9	38.6	1,836.0	46.4	6.1	30.5	2,466.0	44.1
Acanthuridae (Surgeonfishes)	314.5	19.5	965.7	24.4	8.5	42.5	1,288.7	23.0
Siganidae (Rabbitfishes)			60.5	1.5			60.5	1.1
Scombridae (Tunas)			15.4	0.4			15.4	0.3
Subtotal	1,616.6	99.8	3,954.6	99.8	20.0	100.0	5,591.2	99.8
Undifferentiated Fishes	2,815.6	63.5	832.2	16.7			3,647.8	39.5
TOTAL (Finfishes)	4,432.2	92.2	4,786.9	96.3	20.0	82.0	9,239.0	94.2
Octopuses & Squids			6.8	0.1	1.4	5.5	8.2	0.1
Crabs			33.1	0.7	3.0	12.5	33.8	0.3
Spiny Lobsters	373.7	7.8	144.0	2.9			517.7	5.3
Undifferentiated Crustaceans			2.4	<.1			2.4	<.1
TOTAL	4805.6		4973.2		24.4		9,803.2	

rate of 4.3 kg/boat-hour. Even with the improvements in sampling there were a number of days in which this method occurred but interviews could not be obtained. We believe that the GOES underestimated the catch of this method by approximately 31%.

Other Methods

Longlining and gill netting were rarely practiced during FY 85. Together, they produced an estimated harvest of 1.0 m.t. during 236 boat-hours of effort. It is believed that the GOES underestimated the harvest of these methods by as much as 50%.

Overview

Including the 1985 GIFD trolling catch an estimated 323.7 m.t. (90% CL = 46.0 m.t.) of finfish were landed island-wide by boats utilizing a variety of methods beyond the reef margin during FY 85. An estimated 11,195 boat trips were made in which 65, 932 boat-hours were spent fishing. Excluding the GIFD, the average daily participation was estimated at 23 boats per weekday and 43 boats per weekend day or holiday. The overall monthly catch rates (kg/boat-hour) ranged from 3.2 in March to 6.6 in September with an average of 4.9, a 20% drop from the 5.9 average of the previous year. Trolling accounted for 78.7% of the total harvest (254.9 m.t., 90% CL = 38.7 m.t.), bottomfishing comprised 12.2% of the total harvest (39.6 m.t.; 90% CL = 9.2 m.t.), jigging for atulai accounted for 5.7% of the total harvest (18.5 m.t.; 90% CL = 11.2 m.t.), spearfishing accounted for 3.0% (9.7 m.t.; CL not available) of the total harvest, and other rare methods accounted for the remaining 0.3% (1.0 m.t.) of the harvest.

RECOMMENDATIONS

The GOES calculated catches presented in this report underestimate all methods other than trolling and bottomfishing to a certain extent. This is due to the fact that some boats utilizing infrequently sampled methods return during non-surveyed hours (particularly 2400 to 0600 hrs.). A survey method not utilized by the GOES has been devised to account for these boats. During FY 86 we will extend the a.m. sampling period by two hours (0500 to 1100 hrs.). It is anticipated that this will eliminate most of the undersampling and with it, the need to estimate the extent of undersampling. Therefore, we recommend that this job continue and that sampling techniques continue to be refined. Furthermore, we recommend that staff fisheries biologists continue to work closely with NMFS personnel in improving the efficiency and accuracy of our computerized data analysis techniques.

Report prepared by: Robert F. Myers

PROJECT TITLE: Guam International Fishing Derby

PERIOD COVERED: August 2-4, 1985

INTRODUCTION

This year, the Guam International Fishing Derby (GIFD), held on August 2, 3 and 4, 1985, was sponsored by the Guam Fishermen's Cooperative Association. The organizational efforts of the Derby Committee chaired by Johnny S. Chaco made this year's event a successful one. The fisheries biologists from the Division of Aquatic & Wildlife Resources (DAWR) wish to thank the committee for their assistance, and also the competing anglers for their cooperation in providing catch information. This cooperation always helps make our job easier and more enjoyable, as well as insures a more accurate analysis of derby statistics.

Awards were presented to the anglers who landed the first, second, and third heaviest fishes of the following species: blue marlin *(Makaira nigricans)*, yellowfin tuna *(Thunnus albacares)*, wahoo *(Acanthocybium solandri)* and mahimahi *(Coryphaena hippurus)*. As in the past derbies, awards were also given for the greatest 3-day total number of fish caught in the above categories combined, as well as for the largest fish caught in a ladies category, and in a children under age 16 category. Records were also kept in an "other species" category.

PARTICIPATION

As in the past, onshore check-out/check-in stations were set up at the Agana Boat Basin and the Merizo Pier. Daily participation information is listed in Table 1. A total of 129 separate boat trips were recorded during this year's derby with 79.1% (102) of these trips originating from the Agana Boat Basin. Each boat carried an average of 3.0 anglers per trip and pulled an average of 4.0 lines per trip, compared to last year's figure of 3.0 anglers per trip pulling an average of 4.1 lines. The mean fishing trip length of the 1985 GIFD was 10.0 hrs., slightly higher than that of last year's derby (9.1 hrs.).

THE CATCH

A total of 427 fish weighing 4,370.2 kg were caught during the 1985 GIFD. This includes other species as well as the four main derby species (Table 2). The mean catch per boat trip was 33.9 kg up slightly from the 29.5 kg per boat trip of last year's GIFD.

Seventeen blue marlin were caught this year, less than one-fourth last year's record total of 79 (Table 3). They collectively weighed 1,660 kg, or an average of 97.6 kg, more than twice the average weight of those caught in last year's derby. However, this year's winning marlin weighed 178.0 kg, considerably smaller than last year's 215.4 kg winner.

The yellowfin tuna catch was considerably greater than that of last year's derby, consisting of 127 individuals totaling 1,058 kg. Although the average size of those caught exceeded that of last year's derby (7.7 vs. 5.3 kg respectively), the winner was smaller (45.9 vs. 51.7 kg, respectively).

This year's derby produced a record wahoo catch, exceeding the record set last year. Ninety-eight wahoo weighing 922 kg were landed. The average weight of 9.4 kg also

Table 1. Daily participation, effort and catch in the ninth annual Marianas fishing derby.

	DAY 1 AUG 2	DAY 2 AUG 3	DAY 3 AUG 4	DERBY TOTALS
Number of boats	42.0	41.0	39.0	65.0
Number of boat trips	45.0	42.0	42.0	129.0
Number of fishermen	129.0	125.0	139.0	393.0
Average men per boat	2.9	3.0	3.3	3.0
Number of lines fished	180.0	170.0	169.0	519.0
Average lines per boat	4.0	4.0	4.0	4.0
Boat hours	447.0	459.1	386.9	1293.0
Average boat trip length	9.9	10.9	9.2	10.0
Fisherman hours	1285.1	1376.2	1335.2	3996.5
Line hours	1776.2	1861.3	1581.5	5219.0
Number of fish landed	188.0	114.0	125.0	427.0
Kilograms landed	1697.4	1303.2	1369.6	4370.2
Average catch per boat trip	37.7	31.0	32.6	33.9
Average catch per boat hour	3.8	2.8	3.5	3.4
Average catch per man hour	1.3	.9	1.0	1.1
Average catch per line hour	1.0	.7	.9	.8

Table 2. Daily catch composition for the ninth annual Marianas fishing derby.

	DAY 1 - AUG 2			DAY 2 - AUG 3			DAY 3 - AUG 4			TOTAL		
	NUMBER CAUGHT	TOTAL WT-KGS	AVE WT.	NUMBER CAUGHT	TOTAL WT-KGS	AVE WT.	NUMBER CAUGHT	TOTAL WT-KGS	AVE WT.	NUMBER CAUGHT	TOTAL WT-KGS	AVE WT.
MARLIN	5	453.7	90.7	5	428.5	85.7	7	777.5	111.1	17	1659.7	97.6
YELLOWFIN TUNA	68	589.0	8.7	37	325.4	8.8	32	143.8	4.5	137	1058.2	7.7
WAHOO	35	433.6	9.8	40	367.3	9.2	23	209.7	9.1	98	921.6	9.4
MAHIMAHI	11	39.2	3.6	0	0	0	3	37.4	12.5	14	76.6	5.5
SKIPJACK TUNA	68	263.4	3.9	29	153.4	5.3	32	125.3	3.9	129	542.1	4.2
RAINBOW RUNNER	0	0	0	0	0	0	20	35.0	1.8	29	35.0	1.8
BARRACUDA	1	7.5	7.5	2	18.4	9.2	8	40.9	5.1	11	66.8	6.1
DOGTOOTH TUNA	0	0	0	1	5.2	5.2	0	0	0	1	5.2	5.2
TOTALS	188	1697.4	9.8	114	1298.2	11.4	125	1369.6	11.6	427	4365.2	10.2

Table 3. Catch comparison for all Guam or Marianas Fishing Derbies.* Weights are expressed in kilograms (1 Kg = 2.2 lbs).

	1977	1978	1979	1980	1981	1982	1983	1984	1985
MARLIN									
no. caught	9	9	6	12	34	12	13	79	17
total weight (kg)	933.0	511.0	703.0	727.0	2005.0	852.0	964.1	3645.9	1659.7
av. weight (kg)	103.6	56.8	117.2	60.6	59.0	71.0	74.2	46.1	97.6
winning fish (kg)	192.0	75.2	328.0	139.0	145.0	132.0	199.1	215.4	178.0
YELLOWFIN									
no. caught	18**	11	34	50	109	205	100	91	137
total weight (kg)	240.0	255.0	637.0	308.0	1156.0	2377.0	1105.7	479.1	1058.2
av. weight (kg)	13.3	23.2	18.7	6.2	10.6	11.6	11.1	5.3	7.7
winning fish (kg)	46.3	56.8	67.7	51.1	47.7	61.1	55.7	51.7	45.9
WAHOO									
no. caught	7	9	11	12	33	60	36	84	98
total weight (kg)	90.9	102.0	116.0	161.0	543	264.0	359.7	595.3	921.6
av. weight (kg)	13.0	11.4	10.5	13.4	16.5	4.4	10.0	7.1	9.4
winning fish (kg)	22.3	18.9	19.7	23.4	17.0	22.7	24.5	21.3	23.5
MAHIMAHI									
no. caught (kg)	2	4	5	3	1	14	33	0	14
total weight (kg)	13.6	26.4	52.6	39.3	0.8	63.7	195.2	-	76.6
av. weight (kg)	6.8	6.6	10.5	13.1	-	4.6	5.9	-	5.5
winning fish (kg)	8.9	8.9	14.8	15.9	0.8	14.8	11.1	-	14.8
DERBY SPECIES CATCH									
no. caught	36	33	56	77	177	291	182	254	266
total weight (kg)	1277.5	894.4	1508.6	1235.3	3704.8	3556.7	2624.7	4720.3	2716.1
TOTAL CATCH**									
no caught	-	-	-	-	-	-	281	472	427
total weight (kg)							3277.6	5466.4	4370.2

*Based on return catch reports. Only the principal derby species are included.
**Includes all tuna species.

exceeded the 7.1 kg average of last year's derby. The winning wahoo weighed 23.5 kg, also slightly larger than last year's winner.

Fourteen mahimahi weighing 77 kg were landed, an improvement over last year's zero mahimahi catch. This year's winner weighed 14.8 kg.

One hundred and sixty-one individuals of four "non-derby" species were landed accounting for 14.9% (649 kg) of the overall derby catch. The bulk of this (83.5%) consisted of skipjack tuna (bonita). The remainder consisted of barracuda (10.3%) , rainbow runner (5.4%) and a single dogtooth tuna (0.8%).

FISHING AREAS

Unlike the past four derbies at least two of this year's winning fish were caught in northern waters. The winning yellowfin tuna was caught at Rota Banks and the winning mahimahi was caught off Ritidian Point. Although the winning marlin was caught at Galvez Banks, nearly all the other marlin were caught off the northern half of Guam. It is unknown where the winning wahoo was caught.

As in all other years, most of this year's effort was spent off northern Guam (81%; Table 4). Overall catch rates of the five derby species were similar in both northern and southern fishing grounds (2.67 vs. 2.55 kg/boat hour fished, respectively). In the north the best catch rate occurred off Cabras Island (11.1 kg/boat hour fished), due primarily to the capture of a 163 kg. blue marlin in an area that was lightly fished (1% of the overall effort). Otherwise, the Ritidian Point area and northern banks produced the best catch rates of the north (2.67 and 2.54 kg/boat hour fished, respectively). In the south, Galvez Banks produced the best catch rate (3.09 kg/boat hour fished).

Report prepared by: Robert F. Myers

Table 4. Effort and catch rates for derby species during the 1985 GIFD.

Area	Effort (boat-hours) fished)	Catch Rate (Kg/boat-hour fished) Mahimahi	Wahoo	Yellowfin Tuna	Blue Marlin	Total (Derby spp. only)
North (Orote Pt.-Rota Bank)	1007.0	.05	.7	.85	1.33	2.67
N.W. Quadrant	403.8	.06	.39	.02	1.92	2.55
Ritidian	244.8	.12	.29	.05	1.99	2.15
Tanguisson-Uruno	18.5		.58			.87
Asan-Tanguisson	94.9		.27		1.06	1.44
Orote-Asan	26.3		.33		10.84	11.10
N.E. Quadrant	596.7	.01	.63	.93	.94	2.10
Banks	490.8	.01	.75	.68	1.15	2.54
45º Bank	36.8		.27			.40
Rota Bank	454.0	.01	.57	.74	1.24	2.39
Tarague-Pati Pt.	104.8		.08	2.10		1.05
South (S.E. Quadrant Only)	285.0	.10	.77	.69	1.12	2.55
Banks	246.0	.01	.79	.81	1.30	2.81
11-mile Bank	84.8		.38	2.34		1.59
Galvez Bank	117.2		.28		2.73	3.09
Santa Rosa Banks	32.3		.39			.58
Merizo/Cocos	36.8	.77				1.08
Unspecified	10.3					
OVERALL	1293.0	.06	.71	.82	1.28	2.88

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-22
SUB-PROJECT NO.: F
STUDY NO.: F-1
JOB NO.: 2

JOB TITLE: Inshore Fisheries Survey

PERIOD COVERED: October 1, 1984 to September 30, 1985.

SUMMARY

Monthly inshore fisheries surveys were conducted along Guam's shoreline from October, 1984 through September, 1985. An estimated 187.9 metric tons (m.t.) of finfish, accounting for 150 species and 45 families, were caught by inshore fishers during FY 85. The majority of this catch (151.7 m.t.) was harvested through the use of six major inshore methods during an estimated 510,587 person-hours or 407,377 gear-hours of fishing effort. Hook and line fishing was the most popular inshore method, accounting for 66% of total estimated inshore fishing participation. Spearfishing yielded the greatest harvest of approximately 46 m.t. (31%) of finfish. Surround netting was the most successful method in terms of catch rate, yielding approximately 7.18 kg/gear-hour. Beyond this, approximately 15.3 m.t. of marine invertebrates and algae, and 36.2 m.t. of atulai and manahac were harvested during the year. This brings the total annual harvest to 203.2 m.t. Our FY 85 annual estimates are markedly larger than previous annual estimates. Presumably this is based on two factors. FY 85 marked the beginning of night surveys and a more accurate determination of turnover rate was calculated and substituted for the fishable hours ratio. Both of these factors increased the annual estimates.

BACKGROUND

Effective management of Guam's inshore fishery resources requires accumulating data on the types of fishing methods used, fishing pressure, and annual harvest. In order to identify trends in fishing participation, effort, and catch, the Division of Aquatic and Wildlife Resources (DAWR) has been monitoring marine fishing activities since the early 1960's. Over this period of time, survey and analysis methodologies have changed in response to fluctuations in budget and staff. In the last several years, however, field survey techniques have been expanded and refined, while estimates of Guam's recreational/subsistence fishing activities have come to be based on more reliable data analysis techniques.

OBJECTIVES

1. To estimate the total annual inshore participation, effort and harvest of Guam's inshore recreational/subsistence fisheries through statistically valid surveys and analysis.

2. To gather limited biological data that will add to a long-term historical data base on Guam's important inshore fish species.

PROCEDURES

During FY 85, fishing participation surveys were conducted on six randomly selected days per month; four on weekdays and two on holidays (which in this report also include weekend days). These surveys entailed making visual observations of not only participation among the various fishing methods employed, but also of the reef zones and general locations that were fished within the more readily accessible portions of Guam's coastline (Fig. 1, locations 1-72). Based on data collected during nine years of aerial surveys conducted between FY 63 and FY 79, approximately 85% of Guam's inshore fishing activities is known to occur within this area. The starting location for each survey was selected at random and the "circular" direction of driving was alternated between surveys. Observations were made while driving the route once without backtracking. These methods were applied for both day and night participation surveys.

In addition, fishers within one of three survey regions (Fig. 1) were interviewed for catch and effort data over a six-hour interval (starting at 0630 hrs.) during the day and over a five-hour interval at night (starting at 1900 hrs). All survey types (day and night participation and catch) were conducted on the same six randomly selected days for each month.

Our FY 85 data expansion resulted from applying the following formulae to the raw data on each fishing method separately in order to obtain annual estimates.

Participation

$$P = Pw + Ph$$

where P is the estimated total number of participants; and
Pw and Ph are the estimated numbers of people fishing on weekdays and holidays, respectively.

Pw and Ph are calculated as follows:

$$Pw = [(cw \div sw) \div (at \div fd)]\ w$$

$$Ph = [(ch \div sh) \div (at \div fd)]\ h$$

where cw and ch are the total number of people counted during weekday and holiday participation surveys, respectively;

sw and sh are the total number of weekday and holiday participation surveys, respectively;

at is the average number of "fishable hours" per fishing trip.

fd is the average number of fishable hours per day.

w is the total number of weekdays;

h is the total number of holidays.

Fig. 1. Inshore Fisheries Survey Location Codes.

Note: Gear units (i.e., Gw and Gh) may be calculated similarly by substituting gear counts (gw and gh) for person counts (cw and ch).

Effort

$$P\text{-}H = (Tw \times P\text{-}Hwt) + (Th \times P\text{-}Hht)$$

$$G\text{-}H = (Tw \times G\text{-}Hwt) + (Th \times G\text{-}Hht)$$

where P-H and G-H are the estimated total number of person-hours and gear-hours spent fishing, respectively;

P-Hwt and P-Hht are the average number of person-hours spent fishing per weekday and holiday trip, respectively;

G-Hwt and G-Hht are the average number of gear-hours spent fishing per weekday and holiday trip, respectively;

Tw and Th are the estimated number of fishing trips made on weekdays and holidays, respectively.

Tw and Th are calculated as follows:

$$Tw = Gw \div gwt$$

$$Th = Gh \div ght$$

where gwt and ght are the average number of gear units per fishing trip counted on weekdays and holidays, respectively.

Catch

$$C = G\text{-}H\ (Kg \div agh)$$

where C is the estimated total catch in kilograms of fish;

Kg is the actual kilogram-weight of harvested fish as recorded in the catch and effort interviews;

agh is the actual number of gear-hours expended to harvest those fish.

The average annual catch rates that were used to expand the survey data to annual estimates were derived from combined weekday and holiday information collected in all three sampled regions. This was done for each fishing method except for hook and line fishing in Region III. This method was expanded separately for Region III due to a significant difference in hook and line catch rate for that region. Differences in catch rates for cast net, gill net, surround net and spearfishing with snorkel were found to be insignificant between weekdays and holidays and among the three survey regions (See Job 3, Fisheries Data Processing).

Finally, the average daily number of "fishable hours" in each month was determined separately for each fishing method based on tidal limitations. That is, the potential 12-hour daytime and 7-hour nighttime fishing period was reduced for certain methods based on the limitations imposed on those methods by the tide. This "fishable hours" factor is incorporated into the expansion by dividing the average trip length by the average daily possible fishable hours for the year for each method. This calculation acts as an estimated turnover rate.

RESULTS

An estimated 151.6 m.t. of finfish were harvested through the use of six primary methods during FY 85. This catch resulted from a total effort of 50587.8 person-hours and 407377.1 gear-hours. Overall, approximately 0.30 and 0.37 Kg of fish were taken per person-hour and gear-hour, respectively. Estimated participation, effort and harvest values for each fishing method are shown in Table 1. The values in Table 1 are the result of combined estimates for separate expansion of day and night data collections. Tables 2 and 3 present the participation, effort, and harvest for day and night for each method.

Combined estimated values revealed that hook and line was the most popular method accounting for 66% of the participation and 62% of the person-hours. Hook and line averaged 0.14 Kg/gear-hour and yielded the second largest harvest of all methods (45 m.t.).

Spearfishing yielded the largest harvest of 46 m.t. (31% of the total harvest) for all methods and maintained an average catch rate of 1.32 Kg/gear-hour. The increase in spearfishing harvest is attributed to the increased spearing activity and CPUE revealed in the night data collections (Table 3).

Various net fishing methods also contributed to the annual harvest estimates. Cast netting was the most popular net fishing method with 17700.9 participants (11% of the total) or 40508.9 person-hours (8% of the total). An estimated 16.2 m.t. was harvested by cast net fisherman. The most successful net fishing method in terms of catch was gill netting with an estimated harvest of 28.5 m.t. or an average catch rate of 1.49 Kg/gear-hour. Surround netting displayed an unusually low harvest of 14.6 m.t., although it maintained the highest catch rate of 7.2 Kg/gear-hour. This low estimate may have been influenced by the low levels of seasonal recruits of reef flat species. Other methods such as drag net fishing also produced a low yield due to low recruitment levels.

The seasonal harvest of certain juvenile fishes is widely anticipated by local fishers. The FY 85 harvest was marked by small numbers of juvenile goat fish (tiao) especially during March and April; juvenile rabbitfish (manahac) during April, May and June; and juvenile jacks (e'e') primarily during July and August. In addition, harvest of *Selar crumenopthalmus* (atulai) were made throughout an unusually long season. Runs started in mid-May and remained beyond the end of the fiscal year. (see Study F-1, Jobs 1 and 8).

In general, the harvests of tiao and e'e' are fairly well represented within the estimates given in Tables 1-3. However, the take of manahac and atulai are not well represented due to the highly sporadic nature of the harvest and the randomness of our present survey methods. Making accurate estimates for such harvest would require intensive survey effort during the time periods in which these fish are exploited. The seasonal occurrence of juvenile recruitment of *Siganus spinus* and *S. argentius* creates intense fishing for a very short period of time. The effort and harvest are determined separate from the inshore harvest due to the sporadic nature of this fishery and the short season. Catch and effort

Table 1. Combined estimated annual (FY 85) inshore fishing participation, effort, and harvest for day and night data expansions for all methods.

	No. of Persons	No. of Gear Units	No. of Trips	Person-Hours	Gear-Hours	Catch (Kg)
Hook and Line	104132.5	103871.2	54247.8	314181.3	313207.3	45050.3
Cast Net	17700.9	14941.1	12984.3	40508.9	34190.9	16166.3
Gill Net	13616.0	6531.7	5626.3	40064.5	19048.5	28463.5
Surround Net	3879.9	488.5	488.5	16171.8	2031.0	14584.8
Spearfishing	17208.3	16398.6	8224.5	23303.0	34969.2	4642.7
Drag Net	1727.4	309.8	309.8	4624.8	863.5	981.0
Total Finfish	158265.0	142540.8	84452.5	510587.8	407377.1	151699.2
Octopus Fishing	1015.5	1149.0	469.6	2091.1	2387.0	926.3
"Other"	5489.8	5489.8	2251.3	12539.4	12359.4	14346.0
Total	164770.3	149180.0	87173.4	525217.3	422303.5	166971.5
Atulai	1168.5	295.8	265.8	4154.0	1039.3	29579.6
Manahac						6604.7
Total						203155.8

Table 2. Estimated annual (FY 85) inshore fishing participation, effort, and harvest for daytime period for all fishing methods.

	No. of Persons	No. of Gear Units	No. of Trips	Person-Hours	Gear-Hours	Catch (Kg)
Hook and Line	89064.7	89145.5	46401.3	276181.5	276131.5	38618.2
Cast Net	17616.2	14863.1	12866.5	40315.0	34012.2	16082.3
Gill Net	11041.6	5530.6	4760.7	30989.2	15518.0	23343.0
Surround Net	3879.9	488.5	488.5	16171.8	2031.0	14584.8
Spearfishing	10113.8	9440.6	5374.7	20227.9	18879.6	19265.1
Drag Net	260.0	86.7	86.7	942.7	314.2	252.0
Total Finfish	131976.2	119555.0	73296.0	443650.1	351272.7	112145.4
Octopus Fishing	1015.5	1149.4	469.6	2090.1	2387.0	926.3
"Others"	4106.3	4106.3	1783.7	9524.4	9524.4	13142.3
Total	137098.0	124810.7	75549.3	455264.6	363184.1	126214.0

Table 3. Estimated annual (FY 85) inshore fishing participation, effort, and harvest for nighttime period for all fishing methods.

	No. of Persons	No. of Gear Units	No. of Trips	Person-Hours	Gear-Hours	Catch (Kg)
Hook and Line	15067.8	14725.7	7846.5	37999.8	37075.8	6432.1
Cast Net	84.7	78.0	67.8	193.9	178.7	84.0
Gill Net	2574.4	1001.1	865.6	9075.1	3530.5	5120.5
Spearfishing	7094.5	12627.7	2851.8	3075.1	16089.6	27188.1
Drag Net	1467.4	223.1	223.1	3682.1	549.3	729.0
Total Finfish	26288.8	22985.8	11156.5	66937.7	56104.4	39553.8
"Others"	1383.5	1383.5	467.6	3015.0	3015.0	1203.7
Total	27672.3	24369.5	11624.1	69952.7	59119.4	40757.5

data was collected daily during the month-long season and added to the inshore data expansion. Cast nets, drag nets and seins were used to harvest an estimated 6.6 m.t. of which 90% were Siganus species.

The sporadic nature of atulai fishing required separate analysis from the participation data collected during regular participation surveys. The length of the season was determined by the first participation record and the last. The fishable number of days during that period were determined by the ratio of participated days to the number of survey days each month. This ratio was applied to the number of days in each month within the determined season. The number of fishable days was then multiplied by the average catch rate to determine the harvest. This method was applied only to gill net harvest of atulai because harvest estimates of atulai by other methods are included in the annual estimates. The estimate of gill net harvest for atulai was 30 m.t.

In addition to finfish, a significant amount of other organisms were harvested from the reefs throughout the year. For example, the estimated gaff and hook catch amounted to nearly 0.9 m.t. and was totally comprised of octopus which was harvested at the rate of 0.38 Kg/gear-hour. Beyond this, "other methods" (Table 1) were responsible for the harvest of an estimated 14.3 m.t. of various crustaceans, gastropods, bivalves, echinoderms and algae with a catch rate of 1.4 Kg/person-hour of fishing effort. This increases the total inshore estimated harvest to 203 m.t.

FY 85 marked the beginning of night surveys which increased harvest by 24% and provides valuable information concerning the harvest and presentation of Guam's fisheries. Tables 4 and 5 summarize the percentage of fish categories harvested by day and night. This information displays the intense fishing pressure placed on a few fish categories. These results support the need for the existing recreationally important fish project (Study F-1, Jobs 1 and 8).

Finally, the aid of a computerized expansion program greatly reduced the effort required to generate the inshore fisheries expansion and provide the potential for increased manipulation of data.

RECOMMENDATIONS

In FY 85, modifications in data collection and analysis resulted in a more accurate assessment of Guam's inshore fishing activities. The aid of a computer system greatly enhanced the analysis process.

Guam is currently participating in a region-wide program of reviewing and analyzing fisheries data for incorporation into the Western Pacific Fisheries Information Network (WPACFIN). WPACFIN developed a computer program capable of estimating annual inshore harvest based on raw data collections similar to that being used in assessing Guam's offshore fisheries. Since the inshore fisheries survey provides information important for management and planning, it is recommended that this job be continued. Work in developing more efficient survey and analysis techniques for inshore fisheries assessment should also be continued including extending surveys into the night. Finally, serious consideration should be given to temporarily reinstituting the aerial surveying of inshore fishing activities within this job in order to update our assessment of surveyed inshore fishing participation in relation to that for the whole island.

Report prepared by: Gerald Davis

Table 4. Percentage of total day harvest by weight for major fish categories.

Categories	% of Finfish Harvested	% of Total Harvest	Total Weight (Kg)
Surgeonfish	20.3	18.0	22735.0
Snappers	14.5	12.9	16251.7
Trochus		11.9	14996.6
Jacks	11.9	10.5	13353.4
Rabbitfish	11.5	10.2	12911.6
Goatfish	7.6	6.7	8473.4
Octopus		5.7	7048.0
Atulai	5.3	4.7	5899.7
Mullet	4.3	3.8	4836.2
Rudderfish	2.5	2.2	2799.0
Wrasses	2.2	2.0	2495.1
Triggerfish	1.7	1.5	1914.4
Squirrelfish	1.5	1.3	1703.0
Parrotfish	1.2	1.0	1326.2
Other	15.5	7.6	9592.3
	100.0	100.0	126335.6

Table 5. Percentage of total night harvest by weight for major fish categories.

Categories	% of Finfish Harvested	% of Total Harvest	Total Weight (Kg)
Surgeonfish	33.2	32.0	11794.3
Parrotfish	18.4	17.0	6547.1
Goatfish	6.9	6.7	2447.9
Snappers	4.8	4.7	1715.6
Octopus		4.4	1619.8
Squirrelfish	4.3	4.2	1537.8
Wrasses	3.5	3.4	1261.0
Rabbitfish	3.4	3.3	1219.6
Crabs		2.5	929.8
Lobster		2.4	881.1
Mollusks		1.6	574.3
Other	25.5	17.0	6252.8
Total	100.0	100.0	36781.1

PROJECT TITLE: Fish Weir Report

PERIOD COVERED: October 1, 1984 to September 30, 1985

There were six licensed weirs in the Merizo/Cocos Lagoon area during FY 85 (Figure 1). A total of 5,919.0 kg with 1076 days of operation were reported from a total of 70 monthly reports. An additional 514.8 kg was estimated to have been harvested at site 5 during 61 unreported days of operation. There was some theft reported at Sites 4 and 6. To estimate the amount of catch stolen, the average daily catch rate was calculated for each month (not including the days the catch was stolen). The average daily catch value was then multiplied by the number of days the catch was stolen. This yields an estimate of 176.8 kg of stolen fish, increasing the estimated total harvest to 6,610.6 kg.

The reported catch composition for FY 85 is 15.4% lower than that of FY 84. The dominant families were Carangidae (26.2%), Lethrinidae, Lutjanidae (18.9%), Mugilidae (16.3%) and Mullidae (15.1%) (Table 1).

The average harvest per day varied from 3.41 kg at Site 5 to 6.37 kg at Site 3. The mean daily catch rate for all six sites ranged from 4.09 kg/day in February to 12.37 kg/day in November with an overall mean of 5.40 kg/day for the entire year.* The six weirs were operated an average of 189.5 days. Sites 1 and 5 were operated the greatest amount of time (365 days) and Site 2 was operated the least amount of time (31 days) (Table 2). The reason given for the low number of operating days at Site 2 was the unavailability of materials to repair the weir.

The estimated catch of 6,610.6 kg is a decrease of 15.4% from that of FY 84 and is below the record level of 8,413 kg estimated for FY 80**. Although there was an increase of 15.0% in the operating time of the weirs, the overall catch rate was 34.8% lower than that of FY 84, resulting in a lower overall catch.

Report prepared by Robert F. Myers

*Excluding days in which the catch was reported stolen.
**Excluding the estimated catch for *Selar crumenophthalmus*.

Figure 1. Merizo/Cocos Lagoon, Southwestern Guam. The numbers indicate the locations of fish weir sites licensed during FY 85.

Table 1. Composition of the reported fish weir catch for FY 85*.

Fish Family	Reported Catch (Kg)	Percent (%) of Reported Total Catch
Acanthuridae (Surgeonfishes, Kicho)	19.0	0.3
Carangidae** (Jacks, Tarakito)	1548.1	26.2
Carangidae *S. crumenopthalmus* (Atulai)	29.5	0.5
Leiognathidae/Gerreidae (Soapys, Guaguas)	495.7	8.4
Lethrinidae/Lutjanidae (Emperors, Snappers, Mafute)	1117.7	18.9
Mugilidae (Mullets, Laiguan)	967.1	16.3
Mullidae (Goatfishes, Salmoneti)	896.4	15.1
Serranidae (Groupers, Gadao)	66.2	1.1
Siganidae (Rabbitfishes, Sesjun)	102.0	1.7
Others	677.3	11.4
TOTAL	5919.0	99.9

*Excludes the estimated unreported catch for Sep. - Oct. at Site 5.
**Excluding *Selar crumenopthalmus*

Table 2. Average daily catch rates (Kg/day) for the licensed fish weirs operating in the Merizo/Cocos Lagoon region during FY 84[1]

Site	Location	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	FY 85	No. of Days in Operation
1	Tomogi-Afgo	7.12	8.86	8.28	11.25	5.18	3.75	4.28	6.48	5.99	4.45	5.41	3.89	6.26	365
2	Sagua dano - Hasta											5.40		5.40	31
3	Puntan Unai - Poa				4.15	2.83	4.31	8.53	12.49			5.03		6.37	156
4	Ton Vicente - Sagua Usao	3.23	15.87	5.06 (6.58)	3.95 (4.71)	3.93 (4.13)	3.79 (5.22)	5.87 (6.56)	5.22 (6.22)	6.63 (8.52)	5.62 (6.64)	5.29 (6.34)	5.76	4.93 (5.68)	204 (177)
5	Aba - Aang	n.a[2]	n.a[2]	4.40	3.77	3.63	3.25	4.23	4.07	3.81	3.80	4.02	3.37	3.41	365
6	Sagua Usao - Mapua				5.83	4.34 (4.67)								5.12 (5.30)	59 (57)
	All Sites[3]	5.18	12.37	5.91 (6.42)	5.79 (5.94)	3.98 (4.09)	3.78 (4.13)	5.73 (5.90)	7.07 (7.32)	5.48 (6.11)	4.62 (4.96)	5.03 (5.24)	4.34	5.25 (5.40)	1137 (1108)

[1]Numbers in parentheses are based only on days in which the catch was not stolen.
[2]Report forms lost by weir operators; weir in operation during these months.
[3]Means for all six sites combined are based on an average of each site's monthly mean.

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-22
SUB-PROJECT NO.: F
STUDY NO.: F-1
JOB NO.: 3

JOB TITLE: Fisheries Data Processing

PERIOD COVERED: October 1, 1984 to September 30, 1985.

SUMMARY

During FY 85, offshore fisheries survey data collected from FY 77, FY 78, and FY 85 were entered onto computer files and the estimated annual harvest for these years were calculated using the Guam Offshore Expansion System (GOES). The total number of offshore fisheries survey data records is 12, 968. Also, a data base for storing the Guam International Fishing Derby (GIFD) data was created and a program module designed to add the derby results to the annual offshore estimated harvest was developed.

The historical inshore fisheries survey data from FY 77, FY 78, and FY 79 were entered onto computer files. FY 85 catch and participation data were entered onto data bases and analyzed by using the Guam Inshore Expansion System (GIES). The total number of inshore fisheries survey data records now total 27,741.

BACKGROUND

Guam has actively participated in the Western Pacific Fisheries Information Network (WPACFIN) since FY 80 through the membership of the Division of Aquatic and Wildlife Resources (DAWR). Since this time, considerable progress has been made in developing efficient and reliable fisheries management computer programs and systems. Efforts during FY 80 through FY 83 were directed primarily at introducing and training staff biologists on computer functions and software capabilities. But, in FY 84, fisheries data input and analysis increased dramatically with the addition of a second Apple II+ computer and hard disk drive.

Because of the enormous amount of offshore fisheries data collected since the beginning of the offshore fisheries survey program, a fast and efficient means of estimating the total offshore harvest had to be initiated. Therefore, in FY 83, National Marine Fisheries Service (NMFS) personnel, working closely with DAWR staff biologists, developed the Guam Offshore Expansion System (GOES). During FY 84, historical offshore data entry was completed back to FY 79 and the GOES was used to recalculate the annual offshore harvest estimates back to FY 80.

Over the past fiscal years, entry of the inshore fisheries survey data was completed back to FY 80. But, because of the gross differences between the offshore and inshore survey methodologies, a Guam Inshore Expansion System (GIES) could not be developed until further study of the raw data and survey methods was completed.

Job 3, Fisheries Data Processing, has greatly improved over the past fiscal years and has proven to be a valuable asset in support of Guam's offshore and inshore fisheries survey programs. Since its beginning, Job 3 has been funded by the U.S. Fish and Wildlife Service (USFWS), NMFS, and the Western Pacific Regional Fisheries Management Council.

OBJECTIVES

The Objectives of Job 3 for the past fiscal year were as follows:

1. Computerize the DAWR's current and remaining historical marine fisheries data and transfer the finalized fisheries data files and reports to NMFS personnel in Honolulu, Hawaii for regional WPACFIN application.

2. Coordinate with NMFS personnel to develop the most reliable computer software program for obtaining an island-wide annual harvest estimate for Guam's inshore fisheries.

3. Establish a data base for the Guam International Fishing Derby and develop a program module that will include the derby results in with the annual offshore harvest estimates.

PROCEDURES

The "Guam Tournament" module is a program written by NMFS personnel that will directly add the Guam International Fishing Derby (GIFD) results to the GOES offshore fisheries harvest estimate. The module will update the expansion for the month in which the GIFD was held as well as the final annual expansion. The format for the GIFD data base is the same as that for the offshore fisheries data base so that compatibility can be maintained between the two. This is important because the derby results are added directly to the final offshore expansion and, in order for the "Guam Tournament" module to properly execute this function, the derby data must be stored and translated in the same sequence as the offshore fisheries survey data. As an added feature, the "Guam Tournament" module will print a report for each individual boat participating in the GIFD. This report gives the daily results as well as the total catch and effort of the boat for the entire derby.

During FY 84 a student's t-test was performed on the mean annual catch-per-unit-effort (CPUE) over a five year period for the five major inshore fishing methods on Guam. These methods are hook and line, cast net, gill net, surround net, and spear with snorkel. The t-tests were used to determine if there was a significant difference in the mean CPUE's between weekdays and weekend days and between each of the three inshore survey regions (see Job 2, "Inshore Fisheries Survey"). The t-test was performed on each method separately and the results indicated no significant difference between the two type days or the three survey regions except for hook and line, where Region III had a higher mean CPUE than Regions I and II. After consulting with NMFS statisticians, an ANOVA F-test was performed on the same mean CPUE's to determine if the variance over the years had significantly changed. The results indicated no significant difference for each method between weekdays and weekend days ($P>.05$, Table 1) and between each of the three survey regions except for hook and line fishing in Region III ($P<.05$, Table 2). These tests are very important because the function of the GIES is based entirely on the test results.

Table 1. Analysis of variance for the mean weekday and weekend day CPUE's (kg/gear-hour) for the five most commonly used inshore fishing methods on Guam. The mean CPUE's were calculated by method for each of the three inshore survey regions (see Study F-1, Job 2). NS = Not significant (P>.05).

Fishing Method	Source of Variation	df	ss	ms	F	P
Hook and Line	Region 1	1	0.02	0.02	2.92	NS
	Error	8	0.05	0.00		
	Region 2	1	0.00	0.00	0.18	NS
	Error	8	0.08	0.00		
	Region 3	1	0.02	0.02	0.08	NS
	Error	8	0.16	0.02		
Cast Net	Region 1	1	0.03	0.03	0.09	NS
	Error	8	2.39	0.30		
	Region 2	1	0.00	0.00	0.05	NS
	Error	8	1.35	0.17		
	Region 3	1	0.28	0.28	1.85	NS
	Error	8	1.22	0.15		
Gill Net	Region 1	1	0.12	0.2	0.13	NS
	Error	7	6.62	0.95		
	Region 2	1	0.05	0.05	0.38	NS
	Error	8	1.06	0.13		
	Region 3	1	0.40	0.40	0.60	NS
	Error	8	5.38	0.67		
Surround Net	Region 1	1	1.18	1.18	0.24	NS
	Error	8	39.94	4.99		
	Region 2	1	11.93	11.93	3.78	NS
	Error	5	15.77	3.15		
	Region 3	1	0.49	0.49	0.03	NS
	Error	6	84.10	14.02		
Spear (Snorkel)	Region 1	1	0.02	0.02	0.00	NS
	Error	6	9.86	1.64		
	Region 2	1	0.21	0.21	0.23	NS
	Error	6	5.54	0.92		
	Region 3	1	0.52	0.52	0.57	NS
	Error	8	7.25	0.91		

Table 2. Analysis of variance for the three mean regional CPUE's (kg/gear-hour) for each of the five most commonly used inshore fishing methods on Guam (see Study F-1, Job 2). NS = Not significant (P>.05).

Fishing Method	Source of Variation	df	ss	ms	F	P
Hook and Line	Reg 1 to Reg 2	1	0.00	0.00	0.00	NS
	Error	18	0.15	0.00		
	Reg 1 to Reg 3	1	0.11	0.11	8.13	<.05
	Error	18	0.25	0.00		
	Reg 2 to Reg 3	1	0.11	0.11	7.67	<.05
	Error	18	0.25	0.00		
Cast Net	Reg 1 to Reg 2	1	0.00	0.00	0.06	NS
	Error	18	3.77	0.21		
	Reg 1 to Reg 3	1	0.04	0.04	0.19	NS
	Error	18	3.02	0.22		
	Reg 2 to Reg 3	1	0.10	0.10	0.62	NS
	Error	18	2.86	0.16		
Gill Net	Reg 1 to Reg 2	1	0.98	0.98	1.15	NS
	Error	17	14.51	0.85		
	Reg 1 to Reg 3	1	0.31	0.31	0.42	NS
	Error	17	12.53	0.74		
	Reg 2 to Reg 3	1	0.20	0.20	0.26	NS
	Error	18	13.56	0.75		
Surround Net	Reg 1 to Reg 2	1	3.82	3.82	0.83	NS
	Error	15	68.82	4.59		
	Reg 1 to Reg 3	1	4.79	4.79	0.61	NS
	Error	16	125.70	7.86		
	Reg 2 to Reg 3	1	14.94	14.94	1.73	NS
	Error	13	112.29	8.64		
Spear (Snorkel)	Reg 1 to Reg 2	1	0.35	0.35	0.31	NS
	Error	14	15.62	1.12		
	Reg 1 to Reg 3	1	0.98	0.98	0.89	NS
	Error	16	17.64	1.10		
	Reg 2 to Reg 3	1	0.13	0.13	0.16	NS
	Error	16	13.51	0.84		

The catch and effort survey data collected from the three survey regions are combined for each method except hook and line. Hook and line survey data collected in Region III is analyzed separately from data collected in Regions I and II. The two expanded catch estimates are then added together to give a total hook and line estimated catch. All methods for weekdays and weekend days are analyzed separately because of the apparent difference in participation counts between these two type days. The estimated catches for each method are then added together to obtain a total harvest with a corresponding coefficient of variation.

During FY 85, an inshore nighttime fisheries survey was implemented and this data were added onto the daytime inshore fisheries survey data bases. The nighttime survey data is analyzed separately from the daytime survey data. Also, data collected during the seasonal harvest of juvenile rabbitfish *(Siganus spp.)* and atulai *(Selar crumenaphthalmus)* were added to same data bases as the fisheries survey data. However, because of the dissimilarities between the seasonal fisheries and the routine inshore fisheries, the two are analyzed separately.

RESULTS

Offshore Fisheries Survey Data Base Management

The DAWR's offshore fisheries survey data for FY 85 were entered onto computer files and edited for completeness and accuracy. The total number of records for the FY 85 offshore data base are 3,002. Also, FY 77 and FY 78 offshore data were entered onto data bases and the total number of records for these years are 380 and 1,205, respectively. This brings the total number of historical and current offshore records to 12,968. A data base was created for the GIFD and data was entered from the DAWR's derby catch records back to FY 83. The total number of records in this data base are 688.

Based upon the expansion calculated by the GOES and "Guam Tournament" module, the estimated island-wide offshore harvest for FY 85, including the GIFD results, is 328.1 metric tons. For more detailed discussion see Job 1, "Offshore Fisheries Survey".

Inshore Fisheries Survey Data Base Management

The FY 85 DAWR inshore fisheries survey data was entered onto two data bases. The "inshore-catch" and the "inshore-participation" data bases for this fiscal year contain 2370 and 2520 records, respectively. FY 77, FY 78 and FY 79 historical "inshore-catch" survey data entry was completed in FY 85 and their combined total number of records are 2807. This brings the number of "inshore-catch" data base records to 17,447 and the "inshore-participation" records to 10,294.

During FY 85, NMFS personnel and DAWR biologists developed the GIES and used it to calculate a total annual harvest estimate for Guam's inshore fisheries for FY 85. This estimated catch, combining day fishing, night fishing, and seasonal fishing, is 187.9 metric tons of finfish. For more details, see Job 2, "Inshore Fisheries Survey".

Other Fisheries Data Bases

The Species Codes data base was updated in FY 85 to account for misidentified species and new species found in Guam waters. The total number of species presently identified and coded on this data base are 1324. This data base contains records for both finfish and marine invertebrates.

A Fisher Codes data base was established over the past fiscal year in order for DAWR staff biologists to keep better track of the influx of new fishermen and boats into Guam's recreational fisheries. This data base is continually updated and now contains 151 records.

RECOMMENDATION

Since the historical inshore and offshore fisheries survey data have been entered onto computer files, more time can be allocated to analyzing this data and comparing the results to present and future survey data analysis to determine catch, effort, and participation trends. Therefore, offshore and inshore fisheries survey data should be collected and entered on a continual basis in order to maintain the compatibility and efficiency needed to analyze these trends. Copies of the completed inshore and offshore data bases should be continually sent to NMFS personnel in Honolulu for WPACFIN application and for emergency back-up.

Report prepared by Robert D. Rinehart

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-22
SUB-PROJECT NO.: F
STUDY NO.: F-I
JOB NO.: 4

JOB TITLE: Checklist of Fishes

PERIOD COVERED: October 1, 1984 to September 30, 1985.

SUMMARY

The results of independent research conducted prior to the reactivation of this job and information gathered by the Division of Aquatic and Wildlife Resources has been compiled into an annotated checklist of the fishes of the Marianas Islands.

As of this writing, 853 species of shorefishes in 104 families are recorded from the Marianas. All but 22 species in 2 families are known from Guam. An additional 35 species in 26 additional families are recorded from deep slope or mesopelagic habitats within the Fisheries Conservation Zones of Guam and the Commonwealth of the Northern Marianas.

This list and lists of other marine organisms form the basis of computerized files utilized by the Division and the Western Pacific Fisheries Information Network (WPACFIN).

Approximately 60 species new to the Marianas were collected, or discovered in previously collected material, at the Division or the University of Guam Marine Laboratory since the initial termination of this project in FY 81. This material as well as other specimens in the Division collection are currently in the process of being transferred from formalin to alcohol, a better long-term preservative.

As a training aid in fish identification, a color slide program was produced that covers 284 species of fishes of recreational inportance.

BACKGROUND

The task of inventorying the fishes of Guam was initiated in 1963. By 1968 most Division material was transferred to the University of Guam Marine Laboratory collection. By 1975, a total of 673 species in 94 families were recorded in a checklist (Kami et al., 1968) and two supplements (Kami, 1971 and 1975). An additional 8 species were reported in the FY 76 annual report. The project remained inactive after 1976 and was terminated in FY 81. During that time personnel associated with the University independently undertook a similar project recording an additional 114 species from Guam and other islands in the Southern Marianas (Myers and Shepard, 1980; Amesbury and Myers, 1982). Since then, the University has discontinued the project making it desirable for the Division to reinstate it.

Since the publication of the checklist of Guam fishes (Kami et al., 1968), approximately 180 additional species have been discovered in Guam's waters. In addition, considerable revisionary work has been completed on the taxonomy and identification of Indo-Pacific fishes resulting in the obsolescence of many of the names utilized in earlier publications. Consequently many of the species names utilized in the checklist, its supplements, and in references used to identify fishes from this region, are inappropriate. This has created difficulties in identifying many species, in gathering information on their biology, or in creating an accurate and practical list for the Division's computerized data base. For these reasons it has become necessary to compile a comprehensive annotated list of the fishes of Guam that can be used to reconcile the correct species name with inappropriate names used in both the literature and earlier Division projects. The periodic discovery of species new to Guam and the deterioration of some of the older material in the Division and University of Guam reference collections through leakage, evaporation or infestation by insects, has made it desirable to acquire and curate new material on a continuing, but low-level basis. On-going research on the identification and taxonomy of Indo-Pacific fishes make it necessary to monitor the literature and periodically update Division reference lists and identification aids.

OBJECTIVES

1. To compile an up-to-date checklist of the fishes of Guam by reconciling other names still in use, in the recent literature, or on Division files, with the correct name for a given species.

2. To create a numerical code index of Guam fishes that can be easily amended as needed and that can be utilized to retrieve information in the Division's computer banks on any species, regardless of the name given it.

3. To train Division personnel in the identification of recreationally important fish species as needed.

PROCEDURES

1. The literature on Indo-Pacific fishes and other marine organisms was monitored.

2. Contact was made with other researchers studying fishes of Guam and adjacent islands in order to make new knowledge available to the Division in a timely manner.

3. Fishes new to Guam or not yet represented in the collection of the University of Guam were collected, photographed and identified.

4. Specimens stored at the Division were transferred to the University of Guam collection.

RESULTS

The results of independent research conducted by personnel associated with the University of Guam Marine Laboratory and this author prior to the reactivation of Job 4 have been made available to the Division. This information, along with information gathered by the Division, has been compiled into an annoted checklist of the fishes of the Marianas Islands which has been submitted for publication in Micronesica, the journal of the University of Guam (Myers, MS). A copy of the manuscript is on file at the Division and forms the basis of their computerized file. The manuscript and the computerized file are periodically updated, as needed. In addition, the computerized list has been expanded to include other marine organisms associated with fisheries resources.

As of this writing, there are 831 species of shorefishes in 102 families recorded from Guam. An additional 22 species (including 2 additional families) are recorded from other islands in the Marianas and could be expected to occur at Guam. An additional 35 species in 26 additional families are recorded from deep slope or mesopelagic habitats at depths greater than 200 m within the 200 mile Fisheries Conservation Zone of Guam and the Commonwealth of the Northern Marianas.

The list of shorefishes includes 26 photographic records and 19 sight records from qualified sources that are not represented by collected specimens.

Specimens of some of the species recorded from Guam on earlier checklists could not be located. This is particularly true for large specimens that are difficult to preserve, store, or access.

Over the years, all of the fishes collected by the Division and the University had been preserved in formalin (10%). The larger specimens were placed in temporary plastic vats or garbage cans with loosely fitting lids. The smaller ones were placed in screw-top jars lacking rubber seals. A lack of sustained funding or sufficient personnel resulted in considerable neglect from about 1976 to 1984. Leakage, evaporation, or infestations by insects have resulted in the destruction of several preserved fish specimens. Some of the rarer species may never be replaced. Others are slowly being replaced as the opportunity arises.

Although formalin is the preferred fixative, it is not a good long-term preservative and poses a definite health risk to those exposed to it. Consequenlty the Division has transferred all smaller specimens to alcohol (either 70% ethanol or 50% isopropanol), but requires additional resources to transfer large specimens. Since it is anticipated that all Division material will eventually be deposited at the University, transferring the very largest specimens may not be necessary.

The University is presently in the process of inventorying and reorganizing its collection and transferring the jar-stored specimens to alcohol. When this nears completion, the Division material will be transferred there, provided that the prospect for adequate curation is good. Extremely valuable material, such as holotypes, most paratypes, and rare species are generally deposited at a major U.S. Museum accessible to specialists.

It is hoped that the University of Guam collection will be a well-maintained depository of fishes that can be utilized by the Division for depositing new material as well as for accessing material under study.

As a training aid in fish identification, a color slide program consisting of 377 numbered slides and an accompanying list of scientific names has been prepared. The list includes 284 species of fishes of recreational importance encountered on or likely to be encountered on the Division's fisheries surveys. Whenever possible intraspecific variability in growth or coloration is shown. Many of the species included in the slide program are not adequately illustrated in available reference texts.

The slide program is a combination of duplicate slides produced from originals in a private collection made available to the Division and of slides on file at the Division. The program is designed to be expanded as needed to aid in future Division research and training activities.

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Report prepared by Robert F. Myers.

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-22
SUB-PROJECT NO.: F
STUDY NO.: F-1
JOB NO.: 8

JOB TITLE: Studies of Recreationally-Important Inshore Reef Fish.

PERIOD COVERED: October 1, 1984 to September 30, 1985.

SUMMARY

Aspects of the reproductive biology of *Siganus spinus* (sesjun or rabbitfish) and *Mulloides flavolineatus* (salmonetti or goatfish) were investigated. Specimens were collected from October 1984 through September 1985. Determinations were made on female:male sex ratio, spawning activity, size at first maturity (fork length [FL]) and fecundity. Spawning activity for *Siganus spinus* and *Mulloides flavolineatus* are consistent with the general pattern of spawning behavior reported for many tropical reef fish species. Both species exhibit extended spawning periods punctuated by distinct peaks in spawning activity. Lunar cycles may influence spawning activity since both species appear to spawn around the quarter moon. *S. spinus* is reproductively active from March-September with a peak from March-April. This peak preceeds the annual mass recruitment runs of juvenile rabbitfish (manahac) in April and May. Occasionally, large numbers of manahac will also recruit in September. The smallest female rabbitfish found with ripe gonads was 122 mm FL while the smallest ripe male was 108 mm FL. The average size at first reproduction is 112 mm FL. Fecundity was determined as clutch size, not annual production. A 182 mm FL female rabbitfish carried approximately 150,000 eggs.

M. flavolineatus is reproductively active during December and January, March through July, and September. A peak in spawning activity occurs during March and April. The period of juvenile goatfish (tiao) recruitment from March through July begins at the time of peak reproductive activity. The smallest female goatfish with ripe gonads was 135 mm FL and the smallest ripe male was 122 mm FL. The average size at first reproduction for goatfish is 141 mm FL. Clutch size for a 267 mm FL female was approximately 240,000 eggs.

BACKGROUND

In addition to reliable data on fishing participation, effort and harvest, proper management of a fishery requires an understanding of the biology and life history of the important food and sports fish species involved. Such information may be used in making sound management decisions, as well as for establishing government policy and laws which relate to fish and fishing.

This job was initially divided into two parts. The first was begun and completed between FY 82 and 83. Results of this part were presented in the Division of Aquatic and Wildlife Resources (DAWR) annual reports for those respective years. The second portion commenced during FY 82 and was suspended that same year because of personnel limitations and job conflicts. The job was reactivated during FY 84, subsequent to the hiring of an additional staff member.

Based on estimates of total annual harvest, five species of inshore reef fish have been identified as being among the more recreationally-important species within the Guam fisheries. Traditionally, these species are highly desirable as both juveniles and adults, and are subjected to relatively intense fishing pressure. During FY 84, investigations of two of these species, the rabbitfish *Siganus spinus* and the goatfish *Mulloides flavolineatus*, were begun. The FY 84 annual report for this job summarizes information on estimated total length frequency and length-weight relationships based on the historical catch and effort data contained in DAWR's inshore creel survey data bases for these species.

OBJECTIVES

The overall objective of this job is to obtain sufficient information on the biology and life history of selected recreationally-important reef fish species in order to permit an adequate assessment of the need for their management. The specific objective for FY 85 was to study the reproductive biology of *Siganus spinus* and *Mulloides flavolineatus* in order to provide additional information pertinent to the potential management of these species.

PROCEDURES

Field collections of *Siganus spinus* (rabbitfish) and *Mulloides flavolineatus* (goatfish) were made over the twelve month period from October 1984 to September 1985. The most comprehensive sampling effort occurred during the months of December 1984 through September 1985. Fish were obtained through the use of surround nets and by spearing. The collections for each month were ≥ 10 individuals per species.

Fish were weighed to the nearest 0.01g and their lengths were recorded to the nearest millimeter. Gonad development (for both males and females) was categorized as one of the following five stages:

Stage I. Immature: gonad very small and translucent of uniform width throughout.

Stage II. Developed: gonad expanded and ribbon like; development beginning anteriorally.

Stage III. Unripe: gametes fully developed; gametes not mature.

Stage IV. Ripe: gametes fully mature; includes "running" condition.

Stage V. Spent: gonad empty.

Fecundity was determined by the gravimetric method adopted from Snyder (1983). Eggs were counted in advanced Stage III and Stage IV ovaries. The calculations were made as follows:

$$F = \frac{sG}{g}$$

where F = fecundity
s = # eggs in a subsample
G= weight of ovaries (to nearest 0.01g)
g = weight of subsample (to nearest 0.01g)

Sex ratios were determined by the chi square statistic as described in Sokal and Rohlf (1960).

RESULTS

Siganus spinus

Sexual Maturity

A total of 317 specimens of *S. spinus* were collected. Fork lengths ranged from 50-274 mm. The sex could not be determined for 75 individuals. The fork length (FL) for 110 females ranged from 116-274 mm and the FL for 132 males ranged from 108-213 mm. The smallest ripe female (Stage IV) was 122 mm FL while the smallest spent (Stage V) female was 116 mm FL. The smallest ripe (Stage IV) male was 108 mm FL while the smallest spent (Stage V) male was 119 mm FL.

Sex Ratio

The number of males and females obtained in field collections appears to be equal. The chi-square tests the probability that 110 females could be obtained by chance from 242 fish randomly sampled from a population in which the true sex ratio is 1:1. The chi-square for the sampled rabbitfish indicates a probability less than 0.05 that a sample more extreme could be drawn from a population that was half female and half male. Therefore the hypothesis of a 1:1 sex ratio is upheld.

Sex Determination

Sex was determined by internal gonad examination since no external sexual dimorphism was noted. The paired gonads lie adjacent to the vent in the posterior part of the body cavity. Ovaries are distinguished from testes by the presence of a prominent red blood vessel running the length of the ovary. Sex determination in immature fish is difficult since this blood vessel is reduced in size or often abscent. Gonads of immature individuals are opaque white, smooth and laterally flattened. Ovaries and testes in early maturing fish are smooth oblong sacs, creamy white in color. Ovaries of developing and mature females are yellowish in color with an uneven texture. The ovarian membrane is vascularized with a network of fine blood vessels. Testes of developing and mature males are white in color with a smooth texture.

Spawning Cycle

Signaus spinus was observed to have a long spawning period extending from March through September. Peak spawning activity occurred during March,

April and May. Spent individuals were collected only several days prior to or after quarter moons. Therefore, a relationship may exist between lunar cycles and spawning activity. Johannes (1981) and Thresher (1984) report lunar spawning rhythm for other *Siganus* species.

Fecundity

Fecundity for *Signaus spinus* was determined as the number of eggs present in the ovary of Stage IV females. This represents a single clutch size rather than annual production since rabbitfish may be repetitive spawners and the possible number of spawnings per year has not been determined. A 182 mm (FL) female weighing 94.1 grams contained a 7.7 gram ovary pair which produced approximately 148,792 eggs. A 141 mm (FL) female weighing 56.5 grams contained a 17.7 gram ovary pair which produced approximately 190,933 eggs.

Mulloides flavolineatus

Sexual Maturity

A total of 354 specimens of *Mulloides flavolineatus* were collected. Fork lengths ranged from 122-299 mm. Sex could not be determined for 48 of these individuals. For the 166 females, the fork lengths (FL) ranged from 135-299 mm. The 140 males ranged from 122-255 mm FL. The smallest ripe (Stage IV) female was 187 mm FL while the smallest spent (Stage V) female was 135 mm FL. The smallest ripe (Stage IV) male was 195 mm FL while the smallest spent (Stage V) was 185 mm FL.

Sex Ratio

The sampled goatfish population appears to have an equal number of females and males. A chi-square test to determine whether 139 females could be selected by chance for a total sampled population of 235 individuals supported the 1:1 sex ratio. The probability is less than 0.05 that a more extreme ratio could be selected.

Sex Determination

The sampled goatfish did not exhibit any external sexual dimorphism. Therefore, sex was determined by gonad examination. Paired gonads lie in the dorsal part of the body cavity, one on each side of the swim bladder. The ovary is distinguished from testes by a red blood vessel which runs the length of the gonad and mature ovaries are distinguished by the vascularization of the ovarian membrane. Gonads of immature individuals can be difficult to distinguish because of their diminished size. Immature gonads are opaque white, smooth and laterally compressed. Gonad development in both sexes begins anteriorly. Developing and mature ovaries are a creamy light yellow color with an uneven texture. Developing and mature testes are white with a smooth surface.

Spawning Cycle

Mulloides flavolineatus has a long spawning cycle. Ripe and spent individuals were found during December, January, March through July, and

September. An apparent peak in spawning activity occurred in March and April. Spent individuals were found a few days prior to or after the quarter moons. A possible relationship between lunar cycles and mullid spawning activity has been suggested by Thresher (1984). Johannes (1981) recorded Palauan fishermans' reports that *Mulloides flavolineatus* spawn only within a few days of the new moon. Spawning activity for this species on Guam may be associated with lunar cycles.

Fecundity

Fecundity was estimated by counting the number of eggs in subsamples of two Stage IV females and calculating the average number of eggs in an ovary. This estimate only represents the potential number of eggs released at one spawning rather than annual production since *Mulloides flavolineatus* may be a repetitive spawner. The yearly spawning frequency per female has not been determined at this time.

A 267 mm (FL) female weighing 310.60 grams contained a 12.36 gram ovary pair which produced approximately 240,632 eggs. A 200 mm (FL) female weighing 123.64 grams contained a 5.19 gram ovary pair which produced approximately 126,172 eggs.

DISCUSSION

Visual inspections of the gonad condition of *S. spinus* and *M. flavolineatus* have revealed extended spawning periods for both species. Peak months of reproductive activity observed in this study are consistent with the general pattern of spawning behavior reported for many tropical reef species. The distinct peak in reproductive activity for *S. spinus* in March coincides with the seasonal trend toward peak rabbitfish harvest during February and March. Rabbitfish sampled during FY 85 first became reproductively active at 116 mm FL for females and 108 mm FL for males. Fish at this size fall into the range reported to be most heavily harvested on Guam (100-160 mm FL). Fish harvested below the average first reproductive size of 112 mm FL are removed from the population before they are physically capable of making a reproductive contribution to the fishery resource. Seasonal recruitment of manahac (juvenile *S. spinus*) occur during April and May. This occurs one month after the onset of observed peak spawning activity in rabbitfish.

Mulloides flavolineatus appear to have a peak spawning activity during March and April. This time period does not coincide with peak harvests of goatfish which occur in September, December, and June. The period of new recruit arrival (March-July) begins at the onset of peak reproductive activity. Goatfish sampled during FY 85 first became reproductively active at 135 mm FL for females and 122 mm FL for males. Fish harvested on Guam range in size from 62-315 mm FL with the most heavily fished sizes being 80-100 mm FL. The majority (by number) of goatfish harvested are below the minimum size for first reproduction.

RECOMMENDATIONS

The study has provided the data base suitable for a more indepth analysis of the reproductive biology and potential reproductive capacity of *S. spinus* and *M. flavolineatus*. Job 8 should be continued with further statistical analysis on this data. The information generated would be useful as a tool in planning management strategies. Simultaneously, work should be initiated on the biology and life history of other recreationally-important inshore reef fish previously identified as being heavily harvested.

In order to effectively assess the need for the management of a fishery for sustained optimum utilization, conservation and preservation, it is necessary to ascertain the standing stock of the resource. Therefore, it is recommended that a field study be designed and implemented to determine the approximate standing biomass of population of these and other recreationally-important inshore reef fish on both healthy and heavily harvested reefs on Guam.

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Report prepared by Gretchen R. Grimm

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-22
SUB-PROJECT NO.: F
STUDY NO.: F-1
JOB NO.: 10

JOB TITLE: Studies of Recreationally Important Offshore Pelagic and Demersal Fish

PERIOD COVERED: October 1, 1984 to September 30, 1985.

OBJECTIVES

To obtain sufficient information on the biology and life history of selected offshore species to permit evaluation of the need for stock management.

RESULTS

This job was inactive during this segment due to the shortage of staff.

RECOMMENDATIONS

This job should be implemented in Segment 23 if adequate manpower is available.

Report prepared by: Robert D. Rinehart

AQUACULTURE
Funding Source: National Marine Fisheries Service
(P.L. 88-309)
Government of Guam

PROJECT TITLE: Development of Tropical Polyculture Fish Farming

PERIOD COVERED: October 1, 1984 through September 30, 1985.

OVERVIEW

During FY 85, the Division of Aquatic and Wildlife Resources (DAWR) continued to work primarily with the Thai catfish, *Pangasius sutchi*. Thirty of these catfish were placed into a 0.1 hectare pond and fed an improved diet in an effort to obtain fully mature eggs.

In addition, DAWR personnel provided a limited amount of technical assistance to the aquaculture community and the general public of Guam (Table 1). However, the primary role of providing technical and field assistance to local aquaculture farmers has been assumed by the University of Guam Extension Service.

In October and November 1984, Typhoons Vanessa and Bill passed near Guam and caused considerable damage to the island. Losses sustained by the aquaculture farmers of Guam were documented and damage assessment reports were completed by DAWR personnel.

Table 1. People given technical aquaculture assistance from October 1, 1984 to September 30, 1985.*

NAME	LOCATION	AFFILIATION	INTEREST
Frank Jackson	Barrigada	Private	Catfish
Frank Pangelinan	Yigo	Private	Catfish
John Castro	Barrigada Heights	Private	General Interest
John Cruz	Yigo	Private	General Interest
Lyndon Pajarino	Dededo	Private	General Interest
Bruce Tunsil	AAFB	Private	General Interest
William Long	Merizo	Private	General Interest
Bob Button	Talofofo	Private	Pond Construction (Bottom Sealants)
Peter Chiang	Taiwan	Hanaqua Feed Corp.	General Interests
Dr. I-chiu Liao	Taiwan	Tung Kang Marine Lab and National Taiwan University	General Interests
Joe San Nicolas	Inarajan	Private	General Aquaculture
Dan Delong	Mangilao	Private	Shrimp, Prawns & Catfish
John Rasmussen	Mangilao	Private	Prawn & Shrimp
Vernon Brown	NCS	Private	Tilapia
John McNeil	Yigo (Bottom Sealants)	Private	Pond Construction
Catalino Bejado	Agana	Private	Tilapia
Russell Heston	Colorado	Hach Chemical Co.	Water Quality Analysis Supplies
Frank Dayton	Agana	Corps of Engineers	Ponds at Talofofo

*In addition to those listed, numerous local aquaculturists contacted the DAWR during the fiscal year for technical assistance covering a wide range of topics.

ARTIFICIAL REPRODUCTION OF THE THAI CATFISH, *PANGASIUS SUTCHI*

SUMMARY

An attempt was made to obtain complete egg oogenesis with the Thai catfish, *Pangasius sutchi*. The fish were kept in a small earthen pond and fed a specially formulated diet. None of the female fish developed eggs which reached full oogenesis. Although several females appeared to have eggs with a light yellowish tinge during the months of July and August, all others had eggs that remained white. The male catfish usually had abundant milt throughout the project period.

OBJECTIVES

1. To obtain oogenesis and egg release in the Thai catfish, *Pangasius sutchi,* at Guam.

2. To develop a viable methodology for artificially reproducing *P. sutchi* and for rearing its hatchlings to the fingerling stage at Guam.

PROCEDURES

A 0.1 hectare, triangular-shaped pond with a six-inch inflow pipe was used for the project. After the pond was drained and allowed to dry, agricultural limestone (45.4 Kg) was evenly broadcast over the pond bottom. Two composite soil samples taken eight and fourteen days later indicated a soil ph of 7.5 and 8.2, respectively.

Following the last soil sample, the pond was filled to an average depth of one meter. Fifteen days later, on February 20, 1985, ten male and twenty female *P. sutchi* brooders were stocked in the pond. At that time, the brooders had a mean weight of 3.9 Kg.

The normal breeding season for *P. sutchi* in Thailand is during the rainy season. In an attempt to elicit a positive response from the catfish by grossly simulating the onset of a rainy season, the pond was flushed once during the middle of each of four months with freshwater. A submersible pump attached to a four inch pipe was used to lower the water level for flushing the pond. Another flushing period at the beginning of the month was performed to sample the brooders. The catfish were seined into a "corral" which was made by placing steel stakes into the pond bottom in a circle and then dropping a net over the stakes. The brooders were then examined by using a combination of bending the fish and gently rubbing its abdomen near the vent, or by physically sucking out some of the eggs using a plastic catheter. If eggs were obtained, the color and shape were usually observed in a clean plastic petri dish. After flushing the pond and sampling the fish, the pond was refilled to its normal water level as soon as pratical.

A special diet was formulated and fed to the brooders at a rate of 2% of their total combined weight. The diet consisted of the following ingredients: 1) whole wheat flour (55%), 2) fish meal (20%), 3) meat and bone meal (15%), 4) alfalfa fines (4%), 5) broiler grower premix (6%), 6) perma pel (<.002%), 7) one teaspoon of marine fish liver oil (<.002%), and 8) 2400 IU of natural vitamin E (.002%).

Items numbered 1 through 6 above were weighed separately in the laboratory using a triple beam balance and then mixed in a plastic bag. Water was then added to the mixture until it

reached a paste-like consistency. At that time, the vitamin E was added to the marine fish liver oil. After the oil and vitamin E were thoroughly mixed, they were added and thoroughly worked into the paste. The moistened feed mixture was then formed into small balls and thrown randomly into the pond with the brooder catfish. The fish were fed five days a week, usually during the mid-afternoon.

RESULTS

From May 29, 1985 to October 9, 1985, the fish were examined five different times. On July 5, August 6 and September 4, the fish were sampled by seining twice through the pond. On May 29 and October 9, the pond was only seined once. Six catfish were lost during the project due to handling stress or escapement from a holding net into a nearby pond.

Throughout the project the males typically possessed a predominate ridge just before the vent, and usually had copious amounts of white milt. Most females had an enlarged ventral region and a swollen red vent. Eggs were observed to be present primarily from July 5, 1985 to September 4, 1985. However, the vast majority of the eggs were white and immature. A few fish on July 5 and August 4 showed a faint to pale yellow color in their eggs but no attempt was made to fertilize at that time since the eggs did not appear to be completely mature.

During the daily afternoon visits to the pond (usually around 3 pm), the air and water temperatures were taken and recorded. The air temperature had a range of 25-30°C with a mean of 28.5°C and the water temperature had a range of 29-34°C with a mean of 31.7°C. The number of days with observed rainfall slowly increased during the project to a peak of nine in August. On a majority of the days, the sky was partly cloudly with a slight breeze present. The pond colors varied from green to brown during the project. Because the pond was small and protected by large trees on one side, the water surface was usually smooth. The water level flucuated in the pond, and new freshwater was added as soon as possible after the level was found to be low.

DISCUSSION

In attempting to artificially reproduce *P. sutchi,* we have been particularly concerned with the completion of oogenesis among the females. Although our attempts to achieve egg maturation during the 1985 breeding season were unsuccessful, it was hoped that by placing some brooders in a pond environment and providing them with a more nutritionally complete diet they would respond favorably. At this point, we can only speculate as to why the catfish continue to not reach full oogenesis. One or all of the following factors may be involved: age, crowding, environment, repressive factor, character of species, and diet.

Age - The fish were six years old when we started to work with them. This may have affected our results because fish typically exhibit a gradual loss in their ability to reproduce as they grow older (Lagler, Bardach and Miller, 1962). The reproductive potential of our broodstock would have been greater with younger catfish, and it is unfortunate that the work did not start during their second or third year of life.

Crowding - Until the completion of the new DAWR fish rearing facility, the brooders were held in a 16 m^3 cement raceway for the majority of their lives. Brooders being held under crowded conditions often do not exhibit proper gonadal development (Woynmovich and Harvath, 1980). It has been shown that the catfish, *Ictalurus nebulosus,* will not

reproduce if crowded in a pond due to the stress factors involved (Bardach, Ryther and McLarney, 1972).

Environment - It has been reported that the environment in which fish live during their breeding season can have a direct effect on their hormonal balance relative to reproduction (Lam, 1982; Harvey and Hoar, 1979; Fontaine, 1976). Many riverine catfish prefer turbid water during oogensis and ovulation (Woynarovich and Horvath, 1980). The catfish were held in the DAWR raceways at the beginning and the water was nearly always kept clean and transparent. This could have had a negative effect on their gonadal development since they were easily excited under these conditions. Also, the fish may have been overly stressed by the intermittant presence of chlorine in their water supply at the Department of Agriculture. This stress may have resulted in their failure to exhibit strong breeding behavior during the most reproductively active period of their lives.

Repressive Factor - Some fish are known to have the ability to excrete or secrete a "repressive factor" into the water which will inhibit reproduction in ponds (Swingle 1956). A "repressive factor" may have been released by the Thai catfish under the relatively crowded DAWR raceway conditions preventing the full oogensis of the eggs.

Character of Species - *Pangasius spp.* may have a difficult time reaching oogensis in captivity (Atz and Pickford, 1959; Huet, 1979). Although the culture of *P. sutchi* is achievable in ponds, it may be difficult to consistently reach full oogenesis during every breeding season due to their specific characteristics (Potaros and Sitasit, 1976).

Diet - The diet of brooders can have a direct affect on oogenesis (Millikin, 1982). The *Pangasius* brooders being held at the DAWR were dependant on artificial feeds. A lack of natural foods to feed on in the tanks, as well as a deterioration of the vitamin content in the artificial feed, may have prevented the brooders from receiving the necessary nutrients for proper development, growth, and maturation of their reproductive systems during their breeding season.

All or some of the above factors may have prevented the fish from reaching full oogenesis. Our experience indicates that whatever caused the *Pangasius* eggs to not fully maturate may be irreversable even when conditions are changed. However, the catfish stocked in the pond during this report period did appear to respond positively to their new environment even though maturation of the eggs was not obtained. As mentioned previously, pale yellow eggs were observed in some females during the months of July and August. Also encouraging to note was that all these fish appeared to be healthy enough for oogensis to occur within their reproductive tracts during the time spent in the pond environment.

RECOMMENDATIONS

Because of the continued apparent positive response to the pond environment and lack of successful oogensis, the Thai catfish should be left in the pond and checked periodically during the next breeding season, especially July and August, for successful oogenesis.

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Report prepared by: Wayne Kruckenberg

GUAM WILDLIFE INVESTIGATIONS
PROJECT FW-2R-22
Federal Aid in Wildlife Restoration Act

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-22
SUB-PROJECT NO.: W-1
STUDY NO.: 1
JOB NO.: 1

JOB TITLE: Determination of Current Population Size and Distribution of Guam Deer.

PERIOD COVERED: October 1, 1984 to September 30, 1985.

SUMMARY

Hunting license sales decreased 7.7% from 1984 level to 467 licenses sold in FY 1985. Hunter participation also declined slightly from FY 1984 levels of 348 to 294 deer hunters in FY 1985. Hunter harvest and success was slightly higher than that reported the previous year, however, with an estimated 52 deer harvested and a hunter success rate of 17.6% in FY 85. Estimated hunter effort in FY 1985 decreased 46% from the levels of the previous year to 2293 hunter days (1490 8-hour days) spent pursuing deer. The amount of effort expended per deer harvested improved from previous years level to 44.1 hunter days effort per deer harvested (28.7 8-hour days). The most popular deer hunting areas remained Northwest Field (NWF) and Naval Communication Area Master Station (NAVCAMS). The Bolanos, Anao and Cotal Territorial Conservation Reserves were also hunted. Population trend data obtained by spotlight counts indicated a significant increase in the deer population at Pati Point, Andersen Air Force Base (AAFB) and continued low numbers of deer and water buffalo at the Naval Magazine (NAVMAG). A special deer hunt on AAFB to thin the Pati Point deer herd produced modest results with 72 hunters harvesting 12 deer (6 male and 6 females) over 122 hunter days, achieving a hunter success rate of 16.7%.

BACKGROUND

The Guam deer has been under investigation by the Division of Aquatic & Wildlife Resources since 1961. Its distribution, population trends and biology have been described by Wheeler (1979). Deer hunting statistics have been compiled since 1968 through hunter reporting procedures. The regular deer season is October 1 through December 31 with a bag limit of one antlered deer (buck only) per season per license holder exclusive of any special hunt harvest (see special hunt regulation).

OBJECTIVES

To determine the current size and distribution of the deer population of Guam and to monitor population trends.

PROCEDURES

1. Continue monthly spotlight counts on AAFB at 21 per year, 4 per month in May - July and once in other months.

   a. Record number, age, sex and group composition.

   b. Statistically analyze count data and compare with past data to discern population trends.

2. Continue monthly spotlight counts on Naval Magazine with periodic spotlight counts in other areas.

3. Collect hunting statistics via a hunter questionnaire. Analyze hunting statistics for changes in hunter kill, effort, and hunting location.

4. Collect biological data from carcasses killed during regular season and special hunts or from incidental sources such as road kills or confiscated animals.

RESULTS

Deer Hunting Statistics

Hunting license sales decreased 7.7% from FY 1984 levels to 467 licenses sold during Fiscal Year 1985. Based on data from hunter questionnaires, 74.1% of license buyers queried responded they had hunted during the license year. Base on these figures, an estimate of 346 legal hunters went afield last year, down from 397 in FY 1984.

Problems with obtaining adequate supplies prohibited mailing a questionnaire to all license buyers, consequently, only 141 questionnaires were sent out and 27 (19.1%) were completed and returned. Responses by those hunters provided the following information on deer hunting participation and harvest.

Seventeen of the 20 responding hunters (85%) reported they hunted deer during FY 1985 (Table 1). Three deer were reported taken by the 17 deer hunters yielding a success rate of 17.6%. The reported harvest was distributed in NWF-1, Anao-1, and private land-1.

Hunters were also asked to provide information on effort and hunting habits. The shotgun was reported as the weapon of choice for most hunters. It was used by 82% of the reporting deer hunters for 87% of the hunting effort and accounted for the 3 reported kills. A rifle was used by 18% of reporting hunters for 5% of the hunting effort and 12% of the hunters reported hunting with a bow. The 17 responding deer hunters reported they went deer hunting 132 days during the season, an average of 7.8 days per hunter. The hunters also reported hunting an average of 5.2 hours per day, yielding an average of 5.1 8-hour days hunting per season, a decrease in effort from the 7.0 8-hour days reported in FY 1984.

Estimates of total hunter participation, kill, effort, and take per effort were derived from the information on the hunter questionnaires. Based on questionnaire data, an estimated 294 hunters spent 2293 hunter days afield (1490 8-hour days) and harvested 52 deer in FY 1985 with effort of 44.1 hunter days per deer harvested (28.7 8-hour days). These values for hunter participation and effort are

Table 1. Island-wide deer hunting statistics for FY 1985 as based on hunter responses to a harvest questionnaire.

a.	Total license sales for all game species	467
b.	Number of questionnaires sent out	141
c.	Number of hunter questionnaires returned	27
d.	Percent of queried license buyers that responded	19.1%
e.	Number of reporting license buyers that hunted any species	20
f.	Percent of license buyers that hunted any species	74.1%
g.	Estimated total number of legal hunters	346
h.	Number of reporting hunters (20) that hunted deer	17
i.	Percent of reporting hunters that hunted deer	85.0%
j.	Number of deer taken by 17 reporting deer hunters	3
k.	Hunter success	17.6%
l.	Estimated total number of legal deer hunters	294
m.	Estimated total legal deer take	52
n.	Hunter days expended by 17 reporting deer hunters	132
o.	Average number of days spent per reporting deer hunter	7.8
p.	Estimated total number of days spent hunting deer	2293
q.	Number of days spent hunting per deer taken	44.1
r.	Average number of hours spent hunting per day	5.2
s.	Estimated total number of 8-hour days spent hunting deer	1490
t.	Average number of 8-hour days spent hunting deer	5.1
u.	Number of 8-hour days spent hunting per deer taken	28.7

considerably lower than FY 1984, when 348 hunters spent 4211 hunter days (2421 8-hour days) and harvested 46 deer, an effort of 91.5 hunter days per deer (52.6 8-hour days). The above figures indicate that deer hunting improved this year as more deer were harvested with less effort than the preceeding year.

An accurate record of hunter effort and take from the NWF and NAVCAMS military installations is summarized in Table 2. NWF once again received higher hunting pressure than NAVCAMS, probably the highest on-island, and also yielded a larger harvest with far less effort required. In comparison to FY 1984 values, hunter effort decreased at both NAVCAMS, and NWF this past year. Harvest also decreased sharply at NAVCAMS (2 deer versus 7 in FY 1984) but less so at NWF (12 deer versus 14 in FY 1984). The large decrease in harvest at NAVCAMS resulted in a dramatic increase in effort spent per deer harvested in that area. In contrast, it required slightly less effort to harvest a deer in NWF in FY 1985 than the previous year.

Spotlight Count Trends

Spotlight counts were continued on AAFB (21) and NAVMAG (11) during FY 1985. The average number of deer seen per count increased again on AAFB from 79.9 in FY 1984 to 89.9 in FY 1985 (Table 3). Numbers seen during the best 3 months for sighting deer, May-July, increased significantly over FY 1984 levels (Mann Whitney U-Test, $U = 106.5$, $P<0.10$). The largest number of deer seen per count also increased from 118 in FY 1984 to 132 in May of 1985.

The average number of deer seen per count decreased once again at NAVMAG from 9.3 in FY 1984 to 5.3 in FY 1985 (Table 4). No significant difference was detected in numbers from FY 1984 to FY 1985 (Mann Whitney U-Test, $U = 90, 0.20>P>0.10$) but FY 1985 numbers were significantly lower than numbers in FY 1983 when the average count was 16.9 (U-Test, $U = 123.5$, $P<0.002$). The largest count on any given month has also continued to decrease from 35 in FY 1983 to 22 in FY 84, and to 11 in May, FY 1985. It appears the NAVMAG deer herd is continuing to decline.

Andersen Air Force Base Special Hunt

Deer within the runway area and a deer-aircraft collision on 17 January 84 prompted a special hunting during December 1984. Fifty gun and 40 bow special hunt tags were available for distribution by lottery and all 50 gun tags and 27 bow tags were issued. Twelve deer, 6 males and 6 females, were harvested during the special hunt. All 12 deer were harvested by gun hunters. Forty-five gun hunters actually hunted and expended 71 days of effort (out of a possible 91 if all tag holders had hunted both possible days). The 27 bow hunters that hunted expended 51 out of a possible 80 days hunting but were unsuccessful in their efforts at harvesting deer.

Hunter success during the special hunt was 16.7% (12 deer per 72 hunters with valid tags), versus the 17.6% reported in the hunter questionnaires for the regular season. However, the effort expended per deer harvested was much lower at just 10.2 days per deer during the special hunt versus the effort of 333 8-hour days per deer at NAVCAMS, 85.8 hunter days per deer at NWF, or 44.1 hunter days per deer reported in the hunter questionnaire for regular season deer hunting.

Feral Asiatic Water Buffalo

Table 2. Hunter effort and deer take based on official hunter logs from Naval Communication Area Master Station (NAVCAMS) and Northwest Field (NWF), Andersen Air Force Base, during FY 1985.

	October	November	December	Total	Effort/ take
NAVCAMS					
No. hunter sorties	617	287	315	1219	609.5
No. hunter 8-hr days	336	153.5	176.5	666	333
Deer taken	1	0	1	2	
NWF					
No. hunter days	366	328	335	1029	85.8
No. hunter sorties	496	434	424	1354	112.8
No. hunter 8-hr days	261	239.5	246.5	747	62.3
Deer taken	3	3	6	12	

Table 3. Composition of deer herd seen during spotlight counts at Andersen Air Force Base, during FY 1985.

		1984			1985									Summary Statistics			
	COUNT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOTAL	AVE.	SD	CV-%
Unclassed buck	1	4	1	3	0	0	2	4	2	2	7	1	2	70	3.3	2.3	69
	2								6	4	6						
	3								2	5	8						
	4								5	1	5						
	$\bar{x}$	4.0	1.0	3.0	0.0	0.0	2.0	4.0	3.8	3.0	6.5	1.0	2.0				
Spike	1	1	0	0	1	1	2	0	1	2	3	1	1	27	1.3	1.2	92
	2								1	0	1						
	3								4	1	0						
	4								1	4	2						
	$\bar{x}$	1.0	0.0	0.0	1.0	1.0	2.0	0.0	1.8	1.8	1.5	1.0	1.0				
2pt	1	2	0	0	3	1	1	2	0	2	1	2	1	37	1.8	1.6	90
	2								5	0	4						
	3								4	2	0						
	4								3	4	0						
	$\bar{x}$	2.0	0.0	0.0	3.0	1.0	1.0	2.0	3.0	2.0	1.3	2.0	1.0				
3pt	1	6	0	2	6	1	1	1	0	9	3	3	3	83	4.0	2.7	70
	2								4	4	3						
	3								9	5	6						
	4								8	6	3						
	$\bar{x}$	6.0	0.0	2.0	6.0	1.0	1.0	1.0	5.3	6.0	3.8	3.0	3.0				
4pt	1	0	0	1	0	0	0	0	0	0	1	0	0	4	0.2	0.4	211
	2								1	0	0						
	3								0	0	1						
	4								0	0	0						
	$\bar{x}$	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.3	0.0	0.5	0.0	0.0				
Doe	1	37	12	26	56	43	26	47	33	48	66	27	20	973	46.3	17.5	38
	2								69	54	70						
	3								59	63	38						
	4								53	66	60						
	$\bar{x}$	37.0	12.0	26.0	56.0	43.0	26.0	47.0	53.5	57.8	58.5	27.0	20.0				
Yearling	1	6	1	7	6	3	4	2	5	10	4	5	3	95	4.5	2.7	60
	2								5	4	2						
	3								4	1	5						
	4								4	2	12						
	$\bar{x}$	6.0	1.0	7.0	6.0	3.0	4.0	2.0	4.5	4.3	5.8	5.0	3.0				
Fawn	1	2	1	1	2	4	1	9	5	5	4	1	2	103	4.9	3.4	69
	2								8	7	9						
	3								4	13	4						
	4								8	9	4						
	$\bar{x}$	2.0	1.0	1.0	2.0	4.0	1.0	9.0	6.3	8.5	5.3	1.0	2.0				
Unclassed deer	1	34	2	24	35	13	27	38	27	25	23	11	16	495	23.6	9.0	38
	2								33	23	18						
	3								22	16	19						
	4								35	27	27						
	$\bar{x}$	34.0	2.0	24.0	35.0	13.0	27.0	38.0	29.3	22.8	21.8	11.0	16.0				
Total	1	92	17	65	109	66	64	103	73	103	112	51	48	1888	89.9	29.2	32
	2								132	96	113						
	3								108	106	81						
	4								117	119	113						
	$\bar{x}$	92.0	17.0	65.0	109.0	66.0	64.0	103.0	107.5	106.0	104.8	51.0	48.0				
Miles ($\bar{X}$)		5.1	4.9	4.9	5.0	4.9	4.8	5.0	4.9	4.8	4.9	4.9	4.9		4.9		
Km ($\bar{X}$)		8.2	7.8	7.8	8.0	7.8	7.7	8.0	7.8	7.7	7.8	7.8	7.8		7.9		
Deer/10 mi ($\bar{X}$)		180.4	34.7	132.7	218.0	134.7	133.3	206.0	219.4	220.8	213.8	104.1	98.0		158.0	60.9	39
Deer/10 km ($\bar{X}$)		112.7	21.7	82.9	136.3	84.2	83.3	128.8	137.1	138.0	133.6	65.1	61.2		98.7	38.0	39
Bucks-in-velvet	1	5	1	0	0	0	4	3	2	1	5	1	0	48	2.3	1.9	79
	2								0	3	4						
	3								2	2	6						
	4								2	2	5						
	$\bar{x}$	5	1	0	0	0	4	3	1.5	2.0	5.0	1.0	0.0				

Table 4. Composition of deer herd and number of water buffalo seen during spotlight counts at Naval Magazine, FY 1985.

	1984		1985									Summary statistics			
	OCT	NOV^ DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOTAL	AVE.	SD	CV (%)
Unclassed buck	0	0	0	0	0	0	0	0	0	1	0	1	0.1	0.3	332
Spike	0	0	0	0	0	1	0	0	0	1	0	2	0.2	0.4	222
2pt	0	0	0	0	0	0	1	0	1	1	0	3	0.3	0.5	171
3pt	0	0	0	2	1	0	0	0	1	1	1	6	0.5	0.7	126
4pt	0	0	0	0	1	0	0	0	0	0	0	1	0.1	0.3	332
Doe	0	3	0	1	4	1	4	4	2	2	3	24	2.2	1.5	70
Yearling	0	0	0	0	0	0	1	0	0	1	0	2	0.2	0.4	222
Fawn	0	0	0	0	0	0	1	0	0	1	1	3	0.3	0.5	171
Unclassed deer	0	2	1	3	1	2	4	0	3	0	0	16	1.5	1.4	99
Total	0	5	1	6	7	4	11	4	7	8	5	58	5.3	3.1	59
Miles traveled	13.9	14	14	14.1	14	13.6	13.8	13.9	12	14.6	14.6	152.5	13.9		
Km traveled	22.2	22.4	22.4	22.6	22.4	21.8	22.1	22.2	19.2	23.4	23.4	244.0	22.2		
Deer/10 mi	0.0	3.6	0.7	4.3	5.0	2.9	8.0	2.9	5.8	5.5	3.4	42.1	3.8	2.3	59
Deer/10 km	0.0	2.2	0.4	2.7	3.1	1.8	5.0	1.8	3.6	3.4	2.1	26.3	2.4	1.4	59
Water Buffalo	20	34	42	28	17	8	3	57	31	19	29	288.0	26.2	15.3	58
Buffalo/10 mi	14.4	24.3	30.0	19.9	12.1	5.9	2.2	41.0	25.8	13.0	19.9	208.4	18.9	11.1	59
Buffalo/10 km	9.0	15.2	18.8	12.4	7.6	3.7	1.4	25.6	16.1	8.1	12.4	130.3	11.8	7.0	59

^No count was conducted during the month of November, 1984.

Sightings of water buffalo (carabao) were made during the spotlight counts at NAVMAG. The average number of water buffalo seen per count decreased from 34.0 in FY 1984 to 26.2 in FY 1985 (Table 4), a nonsignificant decrease (Mann-Whitney U-Test, $U = 89.5$, $0.20>P>0.10$). The largest number seen on a monthly count increased slightly from 52 in FY 1984 to 57 in FY 1985, yet was still well below the maximum count of 83 in FY 1983. Water buffalo numbers observed in FY 1985 were significantly lower than numbers observed in FY 1983, when the average count was 34.0 versus 26.2 in FY 1985 (Mann-Whitney U-Test, $U = 98.0$, $0.10>P>0.05$). Water buffalo numbers appear to be declining along with deer numbers.

RECOMMENDATION

Continue spotlight counts at present intensity at NAVMAG and AAFB. Collect biological data from carcasses as available.

LITERATURE CITED

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Report prepared by: Paul Conry

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-22
SUB-PROJECT NO.: W-1
STUDY NO.: 1
JOB NO.: 3

JOB TITLE: Determination of Diet Quality of Guam Deer.

PERIOD COVERED: October 1, 1984 to September 30, 1985.

OBJECTIVES

1. To investigate differences in diet nutritional quality between the Pati Point, Andersen Air Force Base (AAFB) and Naval Magazine (NAVMAG) deer herds and between the water buffalo and deer populations on NAVMAG.

2. To establish baseline DAPA index values for the AAFB and NAVMAG deer and carabao herds both seasonally and between years.

3. To investigate seasonal variation in the nutrient quality of key forage plants.

4. To investigate variation in the nutrient quality of individual deer diets.

PROCEDURES

Deer pellets, and *Pennisetum polystachyon* grass samples were collected on a monthly basis from Andersen Air Force Base (AAFB) and Naval Magazine (NAVMAG), areas supporting the two major deer herds on the island. Composite samples of deer pellets composed of 3 pellets from each of 15 different fresh groups, a water buffalo sample composed of about 10 ml of feces from each of 15 different fresh droppings and approximately 100 gms of fresh grass were collected monthly from each area.

Fecal and rumen samples were also collected from deer carcasses examined at the AAFB Special Hunt check station and from deer confiscated from poachers or road kills. Body measurements were taken and a kidney fat and marrow fat content indices of body condition calculated for each carcass, when possible.

The Wildlife Habitat Management Services, Department of Forestry and Range Management, Washington State University, was contracted to perform DAPA (diaminopimelic acid) content analysis on the fecal samples and nutrient analysis for crude protein, gross energy, and Calcium/Phosphorous content on the grass and rumen samples.

RESULTS

Work continued on this job during Segment 22 with 81 samples of deer pellets, water buffalo scats, and grass samples collected and sent for diet quality analysis. Tables 1 and 2 present the preliminary results of analyse performed to date on samples collected during

Table 1. Results of deer diet quality analysis on fecal and grass samples collected from Andersen Air Force Base and Naval Magazine, Guam.

	Andersen Air Force Base					Naval Magazine					
Month/ year	Deer DAPA index	Grass crude protein	Grass gross energy	Grass % calcium	Grass % phos.	Deer DAPA index	Carabao DAPA index	Grass crude protein	Grass gross energy	Grass % calcium	Grass % phos.
1984											
March	0.652	18.2	4.49	0.45	0.38	0.722	0.517	(14.8)	(4.33)	(0.23)	(0.10)
April	0.655	15.1	4.54	0.46	0.27	0.801	0.484	(15.5)	(4.39)	(0.33)	(0.09)
May	0.687	15.6	4.54	0.47	0.28	0.933	0.540	(14.1)	(4.41)	(0.28)	(0.09)
June	0.950	15.3	4.54	0.48	0.29	0.913	0.765	12.9	4.51	0.16	0.07
July	0.921	15.4	4.50	0.43	0.28	1.115	0.820	12.7	4.36	0.19	0.07
August	0.800	13.3	4.43	0.52	0.37	0.719	0.535	10.2	4.43	0.18	0.07
September	0.957	15.0	4.52	0.48	0.44	0.787	0.547	10.1	4.48	0.16	0.08

Table 2. Results of diet quality analysis on samples obtained from deer examined from hunter check stations or road kills during FY 1985.

Deer No.	Date	Area	Fecal DAPA index	Rumen crude protein	Rumen gross energy	Rumen % calcium	Rumen % phos.
84-1	DEC 83	AAFB	0.701	16.3	4.86	1.15	1.33
84-3	MAR 84	AAFB	0.670	17.3	4.54	2.49	2.16
84-7	MAY 84	NCS	0.864	16.9	4.96	2.28	1.93
84-8	JAN 83	NCS	0.883	17.9	4.86	1.59	2.01
84-9	JUN 84	AAFB	0.810	16.7	4.97	1.28	1.11
84-10	JUL 84	AAFB	0.835	17.2	5.07	4.19	2.25
84-12	JUL 84	AAFB	0.795	18.2	4.98	2.15	1.50
84-13	JUL 84	AAFB	0.800	17.7	5.03	2.07	1.57
84-14	AUG 84	AAFB	0.780	21.7	4.94	2.38	2.01
84-15	AUG 84	AAFB	0.799	16.7	4.81	2.89	2.05
84-16	AUG 84	AAFB	0.887	16.3	4.86	2.71	1.79
84-17	JUN 84	AAFB	0.752	19.8	4.95	3.26	2.25
84-18	JUN 84	AAFB	0.841	16.9	4.86	3.00	2.27
84-19	JUN 84	AAFB	0.730	16.1	5.09	1.81	1.30
84-20	JUL 84	AAFB	0.955	13.3	4.99	2.20	1.53
84-21	JUN 84	AAFB	1.158	11.5	5.07	1.48	1.11
84-22	JUN 84	AAFB	0.874	16.2	5.04	2.35	1.69
84-23	MAY 84	AAFB	0.743	16.0	4.91	2.76	1.87
84-24	MAY 84	AAFB	0.627	15.6	5.18	2.97	1.63
84-25	MAY 84	AAFB	0.786	13.9	5.26	2.47	2.09
84-26	MAY 84	AAFB	0.698	18.8	5.08	2.68	1.83
84-27	MAY 84	AAFB	0.591	17.6	5.36	4.44	2.39
84-28	MAY 84	AAFB	0.947	6.1	5.00	1.06	0.85
84-29	MAY 84	AAFB	0.593				
84-30	MAY 84	AAFB	0.729	14.4	5.09	1.78	1.56
84-31	MAY 84	AAFB	0.867	17.0	5.00	2.43	1.48
84-32	MAY 84	AAFB	0.704	8.1	5.13	1.94	1.31
84-33	MAY 84	AAFB	0.822	12.8	5.02	2.71	1.51

Segment 21. Statistical analysis on samples collected during Segment 22 and 23 will be completed during Segment 23, pending receipt of laboratory results.

RECOMMENDATIONS

Continue data collection through February of 1986 and submit samples for analysis. Pending receipt of results, analyze data and prepare a job completion report.

Report prepared by: Paul Conry

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-22
SUB-PROJECT NO.: W-1
STUDY NO.: 2
JOB NO.: 1

JOB TITLE: Preparation of a Status Report on Wild Pigs.

PERIOD COVERED: October 1, 1984 to September 30, 1985.

OBJECTIVES

To prepare a status report on wild pigs to be used in planning future work.

RESULTS

Progress was made toward completion of this job during Segment 22. Additional data on wild pig food habits and reproductive biology were collected from hunter check stations at Northwest Field, Andersen Air Force Base (NWF) during FY 1985. Thirty-nine carcasses were examined during Segments 21-22 with reproductive tracts collected from females. Twenty-two stomachs were also collected from NWF and analyzed for food habits during this segment. The data is currently being entered into a computer data base and will be analyzed for incorporation into the status report.

RECOMMENDATION

This job will be continued in Segment 23 and completed, if adequate resources are available. Additional data on female reproductive biology will be collected during the FY 1986 hunting season and included in the status report.

Report prepared by: Paul Conry

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-22
SUB-PROJECT NO.: W-1
STUDY NO.: 2
JOB NO.: 2

JOB TITLE: Population Size and Distribution of Wild Pigs on Guam.

PERIOD COVERED: October 1, 1984 to September 30, 1985.

SUMMARY

Hunter participation, effort, and harvest decreased in FY 1985 from the record highs obtained in FY 1984. An estimated 294 pig hunters spent 5174 days (3234 8-hour days) hunting pigs and harvested an estimated 706 pigs, a decrease of 13.3% in hunter participation, 33.6% in hunter effort, and 34.9% in harvest. Hunter success decreased as well from 66% in FY 1984 to 47% this year. However, the average take per successful hunter increased this year to 5.1 pigs versus 4.8 pigs in FY 1984. The effort expended for each pig harvested also improved slightly from 7.6 days/pig in FY 1984 to 7.3 days/pig in FY 1985. The military installations of Northwest Field, Andersen Air Force Base (NWF) and Naval Communications Area Master Station (NAVCAMS) remained the most popular pig hunting areas with Bolanos and Anao Conservation Reserves and other private lands also listed as areas hunted.

BACKGROUND

The wild pig *(Sus scrofa)* is one of Guam's most popular game mammals. The wild pigs on Guam descend from stock introduced by the Spanish during their 300-year rule on the island. Wild pigs are found island-wide, though appear to be most numerous in the limestone forests of the north and the ravine forests of southern Guam. Depredation on agricultural crops is often a problem, especially for farmers in southern Guam during the dry season. Fieldwork on pigs in the past has been concentrated on military lands. There is a need to assess pig populations in other areas of the island, particularly in the south, where pigs may be under-harvested and where crop damage by pigs is a common complaint. The legal hunting season for pigs is year-round in southern Guam (south of Route 4) and October 1 through March 31, island-wide. Bags limits are 2 pigs per day and 30 per season.

OBJECTIVES

To monitor trends in pig population size and hunter participation and harvest.

PROCEDURES

1. Record pig sightings during deer spotlight counts, and observations of pigs or pig sign during other fieldwork.

2. Monitor hunter participation and harvest during the legal hunting season.

RESULTS

Overall license sales decreased 7.7% from FY 1984 to 467 licenses sold in FY 1985. Problems with obtaining an adequate supply of materials prohibited a complete mailing of the annual harvest questionnaire; consequently, only 141 questionnaires were mailed out this year. Twenty-seven license holders returned their surveys and of that, 20 (74.1%) reported they had actively hunted at sometime during the year. Those figures produce an estimate that 346 persons legally hunted during FY 1985, a decrease of 13% from FY 1984 levels.

Based on questionnaire responses (Table 1), 85% of reporting hunters hunted pigs in FY 1985, a slight decrease from the 90% reported in FY 1984. Hunter success dropped considerably this year from the 66% in FY 1984 to 47% in FY 1985, but the average kill per successful hunters increased slightly from 4.8 in FY 1984 to 5.1 pigs in FY 1985. Pig hunters spent an average of 17.6 days effort (11.0 8-hour days) hunting pigs over the entire season, a decrease of 28% from FY 1984. However, the amount of effort required to take a pig improved slightly from 7.6 days in FY 1984 to 7.3 days effort per pig taken in FY 1985.

Estimates of total harvest and hunting effort were derived from hunter questionnaires. An estimated 294 pig hunters spent 5174 days (3234 8-hour days) hunting pigs and harvested 706 pigs in FY 1985. Those estimates are consequently lower than the estimates of 339 hunters hunting 8293 days (4872 8-hour days) and harvesting 1085 pigs in FY 1984. In summary, FY 1985 had a decrease in hunter participation (13.3%), hunter effort (33.6%), and hunter harvest (34.9%).

Pig hunting remained popular beyond the traditional 3 month October - December joint deer and pig season. An estimated 41% of the pig hunters continued to hunt throughout the October-March season in northern Guam and year-round season in southern Guam.

The shotgun was the weapon most commonly used to hunt pigs and was used by 83% of reporting hunters and took 78% of the pigs harvested. The rifle was the second most popular weapon for pig hunting and it was used by 23% of the pig hunters and accounted for 22% of the harvest. One of the 17 reporting pig hunters (6%) hunted with bow and arrow but was unsuccessful in harvesting a pig with that weapon. A larger, more accurate sample would no doubt indicate better success by archery hunters than reported above. None of the reporting pig hunters responded that they had successfully taken a daily limit of 2 pigs.

The military bases on the northern end of the island were once again the most popular areas to hunt. Of the 17 reporting pig hunters, 35% hunted NAVCAMS, and 29% hunted NWF. Territorial conservation reserves of Bolanos and Anao were hunted by 24% and 12%, respectively, of the reporting hunters. Private property was also hunted by 24% of the sampled hunters.

An accurate record of hunting activity and harvest was kept at NAVCAMS and NWF hunting areas by military personnel. Hunting pressure and take decreased in both areas from the FY 1984 levels (Table 2) with hunter sorties down 23% at NAVCAMS and down 20% at NWF. Hunter effort dropped to 962.5 8-hour days at NAVCAMS and 1049.5 8-hour days (1425 hunter days) at NWF. The harvest also declined in FY 1985 dropping to 133 pigs (versus 148 in FY 1984) at NAVCAMS and 158 pigs (versus 181 in FY 1984) at NWF. However, it required less effort to harvest a pig in FY 1985, 7.2 8-hour days at

Table 1. Island-wide Pig Hunting Statistics for FY 1985 as based on hunter responses to a harvest questionnaire.

a.	Total license sales for all game species	467
b.	Number of questionnaires sent out	141
c.	Number of questionnaires returned	27
d.	Percent of queried license buyers that responded	19.1%
e.	Number of reporting hunter (27) that hunted any species	20
f.	Percent of license buyers that hunted	74.1%
g.	Estimated total number of legal hunters	346
h.	Number of reporting hunters that hunted pigs	17
i.	Percent of reporting hunters that hunted pigs	85.0%
j.	Number of successful pig hunters	8
k.	Hunter success	47.1%
l.	Number of pigs taken by the 17 reporting pig hunters	41
m.	Average number of pigs taken per pig hunter	2.4
n.	Average number of pigs taken per successful hunter	5.1
o.	Estimated total number of legal pig hunters	294
p.	Estimated total legal pig take	706
q.	Reported number of hunter days expended by 17 pig hunters	300
r.	Average number of days spent per reporting pig hunter (q h)	17.6
s.	Days of hunting effort per pig taken	7.3
t.	Estimated total number of days spent hunting pigs	5174
u.	Average number of hours spent hunting per day afield	5.0
v.	Estimated total number of 8-hour days spent hunting	3234
w.	Average number of 8-hour days spent hunting	11.0
x.	Number of 8-hour days hunting per pig taken	4.6
y.	Number of reporting hunters hunting after end of deer season	7
z.	Percent of hunters hunting after deer season	41.2%
AA.	Number of reporting hunters hunting pigs in the south during the extended season (Apr. - Sept.)	1
BB.	Percent of hunters hunting in south during the extended pig season	5.9%

Table 2. Hunter effort and pig take based on official hunter logs from Naval Communication Station and Northwest Field, Andersen Air Force Base, during FY 1985.

Month	Naval Communication Station			Northwest Field			
	No. hunter sorties	No. hunter 8-hour days	Pig take	No. hunter days	No. hunter sorties	No. hunter 8-hour days	Pig take
1984							
October	617	336	38	366	496	261	46
November	287	153.5	8	328	434	239.5	22
December	315	176.5	25	335	424	246.5	30
1985							
January	200	103.5	25	164	207	122.5	16
February	162	83.5	14	42	58	32	9
March	209	109.5	23	190	244	148	35
Total	1790	962.5	133	1425	1863	1049.5	158
Effort/ pig taken	13.5	7.2	--	9.0	11.8	6.6	--

NAVCAMS (versus 8.4 8-hour days in FY 1984) and 6.6 8-hour days at NWF (versus 6.7 8-hour days in FY 1984).

RECOMMENDATIONS

Continue to monitor the annual pig harvest and hunter participation.

LITERATURE CITED

Aquatic and Wildlife Resources Division. 1983. Job Progress Report - Federal Aid to Fish and Wildlife Restoration. Guam Dept. of Agriculture.

Report prepared by: Paul Conry

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-22
SUB-PROJECT NO.: W-1
STUDY NO.: 2
JOB NO.: 4

JOB TITLE: Wild Pig Biology and Natural History

PERIOD COVERED: October 1, 1984 to September 30, 1985.

OBJECTIVES

To obtain basic biological information on wild pigs through the examination of hunter-killed pig carcasses.

SUMMARY

Hunter-killed wild pig carcasses were examined at hunter checking stations and biological data were collected.

BACKGROUND

The wild pig (*Sus scrofa*) is one of Guam's most popular game mammals. In order to improve management of this wildlife resource, the Division began to collect biological information from hunter-killed pig carcasses during Segment 21 under Job W-2-2. This activity continued during Segment 22, when it was developed as a separate Job.

PROCEDURES

1. Conduct Hunter Checking Stations at selected areas and examine hunter-killed pig carcasses.

2. Collect basic biological information from carcasses pertaining to reproductive biology, growth rates, body condition, and food habits.

RESULTS

Hunter check stations were conducted at Northwest Field (NWF) and Andersen Air Force Base (AAFB) during FY 1985 (Segment 22).

A total of thirty-nine carcasses were examined during Segment 21-22, with reproductive tracts collected from females. Twenty-two stomachs were also collected from pigs killed by hunters in NWF during Segment 22 and analyzed for food habits. These data are currently being entered into a computer data base and will be further analyzed for incorporation into the status report under Job 1-2-1.

RECOMMENDATION:

Continue this Job through Segment 23. Continue to collect and analyze data, and incorporate results into a status report scheduled to be completed under Job W-1-2-1 in Segment 23.

Report prepared by Paul J. Conry

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-22
SUB-PROJECT NO.: W-2
STUDY NO.: 1
JOB NO.: 1

JOB TITLE: Preparation of a Status Report on Philippine Turtle Doves.

PERIOD COVERED: October 1, 1984 to September 30, 1985.

OBJECTIVES

To prepare a status report on Philippine Turtle Doves for use in planning future work.

RESULTS

Substantial progress was made toward completion of this job during Segment 22 with the first draft of the status report near completion at this time. Considerable information has been included in this report spanning over 20 years of work and observations by DAWR Staff. Early information on dove population trend, distribution, nesting biology movements, and food habits is being combined with recent work on status, distribution, population trend, nest success, nesting biology, and food habits. Considerable effort was expended during Segment 22 on compilation, analysis, and interpretation of pre 1983 data as well as collection, analysis, and interpretation of recent data. The on-going work on this status report has also involved library research into the historical status and management history of the turtle dove in the Marianas. The nesting success segment of this technical report has been completed and submitted as a professional paper for publication (Conry, in review). Food habits analysis has been completed on 70 dove stomachs with the data analyzed, interpreted, and that segment of the status report written. Other segments of the report completed to date include Study Area, Methods, Historical Background, and Results (Description, Nesting Biology, Movements and Habitat Use, Food Habits, and Age Classification Guide). The remaining sections, Distribution and Status, Breeding Season, Decimating Factors, Management Section and Discussion will be completed in the near future.

RECOMMENDATION

This job will be completed in Segment 23 and published, if adequate resources are available.

LITERATURE CITED

Conry, P.J. In Review. High predation by brown tree snakes on Philippine Turtle Dove nests on Guam.

Report prepared by: Paul Conry

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-22
SUB-PROJECT NO.: W-2
STUDY NO.: 1
JOB NO.: 2

JOB TITLE: Population Numbers and Distribution of Philippine Turtle Doves.

PERIOD COVERED: October 1, 1984 to September 30, 1985.

SUMMARY

A 2-year moratorium was placed on the hunting of Philippine Turtle-Doves in June of 1985 to reduce overall losses in a declining dove population. Stationary counts at Northwest Field (NWF) and roadside counts at the Conventional Weapons Storage Area (CWS) on Andersen Air Force Base (AAFB) declined significantly ($P<0.01$ at NWF and $P<0.02$ at CWA) from FY 1984 levels to an average of 42.4 birds per count at NWF and 42.8 birds per count at the CWA. The native Marianas Fruit-Dove and White-throated Ground-Dove also continued to decline at NWF with only 1 fruit-dove and 3 ground-doves recorded in 23 surveys, versus 33 fruit-doves and 13 ground-doves recorded in 20 surveys in FY 1984. A recent nesting success study on Philippine Turtle-Doves in forested habitat on NWF and man-made habitat in the airfield compound on AAFB found extremely low nesting success of 0.7% in forested habitat and 21.2% in the man-made habitat. Predation was the major cause of nest failure accounting for 92.7% of losses. The brown tree snake was identified as the major predator responsible for 78.9% of all losses. Small mammals also preyed on nests accounting for 12.8% of all losses, but only took eggs.

BACKGROUND

The Philippine Turtle Dove (*Streptopelia bitorquata*) was introduced to Guam by the Spanish during their early colonization of the region, circa 1771 (Baker 1951) and has been regulated as a game bird since as early as 1903. The most recent hunting regulation, implemented in 1984 and remains in effect to date, restricted the hunting season to the month of July with a daily limit of 5 birds and a season limit of 20 birds. However, a recent nest predation study (Conry, in review) indicated that high nest predation primarily by the introduced brown tree snake (*Boiga irregularis*) caused extremely low nest success, 0.7% in forested habitat and 21.2% in man-made habitats. The poor nesting success combined with decreasing numbers prompted concern for the ability of the dove population to produce enough birds to withstand the heavy predation losses and support recreational hunting without continued losses in the base population of doves. As hunting mortality is the only controllable source of loss to the population, the Division proposed a 2-year moratorium on hunting to reduce overall losses and attempt to maintain the dove population until the snake can be brought under control. In June 1985, the Director of Agriculture adopted the moratorium that closed the Philippine Turtle Dove season for the 1985 and 1986 calendar years. Prior to the July 1987 season, the department will evaluate the status of the dove population and nesting success and decide whether to reopen the season or continue the moratorium.

OBJECTIVES

1. To determine present population levels and distribution, and monitor population trends.

2. To investigate nesting success and causes of nest failures.

PROCEDURES

Call-count and roadside-count surveys were conducted at Northwest Field (NWF) and the Conventional Weapons Storage Area (CWA) on Andersen Air Force Base (AAFB). Both surveys were conducted twice monthly in early morning. The call-count survey consisted of counting the number and species of doves seen or heard during a 5-minute period at 10 stations in NWF plus the number of doves seen enroute between stations. The roadside-count survey at CWA involved counting the number of Philippine Turtle-Doves seen while driving at 25 km per hour along an established 32 km route. The Philippine Turtle-Dove is also censused in a bi-weekly roadside-count survey conducted in 3 areas of northern Guam (Job W-1-3).

Nesting success of the turtle-dove was studied in forested habitat at NWF and in man-made habitat in a developed area within the present-day airfield compound. Active nests were located and individually marked for observation. Active nests were visited on a 2 to 4 day interval until the nest was lost or the young fledged. In cases where eggs or young disappeared, the site was carefully searched for clues indicating the cause of the disappearance. Data were collected and analyzed according to the Mayfield method (Mayfield 1975). Details of study are presented in Conry (in review)

RESULTS

Dove Hunting Statistics

A 2-year moratorium on hunting Philippine Turtle-Dove was adopted by the Director of Agriculture in June of 1985. Consequently, no legal hunt took place during FY 1985 nor will a legal hunt be held in FY 1986.

Population Surveys

Call count surveys and roadside counts were continued in NWF and the CWA on Andersen Air Force Base (Table 1). The mean number of doves observed per count at NWF declined from 59.6 in FY 1984 to 42.4 in FY 1985. Counts were significantly lower in FY 1985 than the previous year (Mann Whitney U-Test, $U = 362.5$, $P<0.01$; Sokal and Rohlf 1981). Likewise counts in the CWA also were significantly lower in FY 1985 than in FY 1984 (Mann Whitney U-Test, $U = 286$, $P<0.02$). Mean numbers observed per count in the CWA declined from 57.3 in FY 1984 to 42.8 in FY 1985.

The native Mariana Fruit-Dove (*Ptilinopus roseicapilla)* and White-throated Ground-Dove (*Gallicolumba xanthonura)* have continued to decline. In FY 1984, 33 fruit-doves and 13 ground-doves were counted versus 1 fruit-dove and 3 ground-doves observed in FY 1985. The single fruit dove was last heard in October 1984. It appears these 2 species are down to just a few individuals.

Table 1. Results of Philippine Turtle-Dove surveys at Northwest Field (NWF) and Conventional Weapons Area (CWA) on Andersen Air Force Base, Guam during FY 1985.

	NWF Surveys			CWA Surveys			
Month	1	2	Average	1	2	3	Average
October	42	37	39.5	60	40		50.0
November	21	52	36.5	44	40	49	44.3
December	46	28	37.0	23	35		29.0
January	22	37	29.5	30	52		41.0
February	28	29	28.5	45	39		42.0
March	31	29	30.0	44	35		39.5
April	44	42	43.0	50	37		43.5
May	63	52	57.5	57	49		53.0
June	67		67.0				
July	54	69	61.5	37	36		36.5
August	58	34	46.0	47	40		43.5
September	44	46	45.0	51	44		47.5
Average count			42.4				42.8

The declining trend in the turtle dove and native dove populations as documented by the counts at NWF and CWA further documents the general decline in Guam birds. Philippine Turtle-Dove numbers remain low throughout the entire island.

Nesting Success

Conry (in review) provides a detailed analysis of turtle-dove nesting success in northern Guam. Nest success was very low in forested areas on NWF (0.7%) and better, but still low, in man-made habitats in the airfield compound (21.2%). Predation was the major cause of egg and nestling mortality and accounted for 92.7% of all losses. The brown tree snake, *(Boiga irregularis)*, was identified as the major predator and was responsible for 78.9% of all losses. Small mammals also preyed on dove nests accounting for 12.8% of all losses, but only took eggs. Predation is clearly having a devastating impact on the reproduction of the turtle-dove, and assumably all other forest nesting birds.

RECOMMENDATION

1. Continue call count and roadside count surveys in northern Guam to monitor distribution, relative abundance and population trends of the Philippine Turtle-Dove.

2. Continue to monitor nesting success.

LITERATURE CITED

Aquatic and Wildlife Resources Division. 1984. Job Progress Report. Federal Aid to Fish and Wildlife Restoration, Dept. of Agriculture, Government of Guam, Agana, Guam.

Baker, R.H. 1951. The avifauna of Micronesia, its origin, evolution, and distribution. University of Kansas Pub. 3(1):1-359.

Conry, P.J. In Review. High predation by brown tree snakes on Philippine Turtle-Dove nests on Guam.

Report prepared by Paul Conry

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-22
SUB-PROJECT NO.: W-2
STUDY NO.: 2
JOB NO.: 1

JOB TITLE: Preparation of a Status Report on Black Francolin.

PERIOD COVERED: October 1, 1984 to September 30, 1985.

OBJECTIVES

To prepare a status report on Black Francolin to be used in planning future work.

RESULTS

Progress was made toward completion of this job during Segment 22. Additional data on francolin population status and distribution was collected during Segment 22 and data collected during Segments 20-22 was compiled and analyzed. Food habits analysis on 116 francolin stomachs was completed during this segment and the data entered into a computer data base. A computer program was written to analyze results and the data is ready to be incorporated into the status report. Necropsies were completed during Segment 22 on 143 francolin carcasses obtained from hunter check stations or collecting efforts of DAWR staff during Segments 20-22. The data is currently being entered into a computer data base and will be analyzed for incorporation into the status report.

RECOMMENDATIONS

This job will be continued in Segment 23 and completed if adequate resources are available.

Report prepared by: Paul Conry

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-22
SUB-PROJECT NO.: W-2
STUDY NO.: 2
JOB NO.: 2

JOB TITLE: Population Size and Distribution of Black Francolin on Guam.

PERIOD COVERED: October 1, 1984 to September 30, 1985.

SUMMARY

Black Francolin were legally hunted during a 2 month split season, one month each in January and July. An estimated 104 hunters spent 624 days hunting and harvested 468 birds during FY 1985. The January season was the more popular of the two accounting for 345 days hunting and 255 birds harvested. The Dandan area was the most popular area to hunt francolin on the island with the Bolanos, Nimitz Hill, Ordot, and Ija areas also reported as hunted. Black Francolin numbers appear to have stabilized with no significant difference detected in counts at the Dandan area between FY 83-84 and FY 84-85 counts.

BACKGROUND

In 1961, 171 Black Francolin *(Francolinus francolinus)* were introduced in southern Guam as part of the Foreign Game Bird Introduction Program of the U.S. Fish and Wildlife Service. Surveys conducted in 1980 indicated the population was adequately established in most parts of southern Guam to open a hunting season. Regulations were promulgated to open a 1-month season in December 1981 with a 4 bird daily limit and a 20 bird season limit. Francolin populations continued to increase from 1980-1982 but hunting pressure remained low, probably because of the unfamiliarity of the hunting public with the sporting qualities of the bird. With the bird population consisently increasing and little hunting pressure, the francolin season and bag limits were further liberalized in FY 1983 to a 2 month-split season, 1 month in January and 1 month in July, with the bag limit increased to 5 bird per day, no season limit. The division arranged a special hunt in the Dandan area in southern Guam during the last 2 weekends of July 1983 to obtain carcasses for disease sampling and biological data. A number of hunters participated and successfully harvested birds. No evidence of disease was found in the specimens examined. Regulations implemented in FY 1983 remain in effect todate with hunter participation and adherence to game laws monitored by spot checks by Division biologists and conservation officers.

OBJECTIVES

To determine current relative abundance and current distribution of Black Francolin on Guam and monitor population trends and hunter harvest.

PROCEDURES

1. Conduct monthly call count surveys in areas of savannah habitat.

2. Conduct pre and post hunt call count surveys in the Dandan area.

3. Monitor hunter harvest and collect data on harvested birds.

    a. Collect information on hunter effort and take at hunter check station.

    b. Collect data on age ratios, sex ratios, reproductive status, and food habits of harvested birds.

    c. Compile and analyze information on francolin hunting statistics from a hunter questionnaire distributed after the season.

RESULTS

Francolin Hunting Statistics

The legal season and bag limit for Black Francolin is a 2 month split season, January 1-31 and July 1-31, with a daily bag limit of 5 birds and no season limit. The split season provides bird hunters an opportunity to hunt birds twice and should encourage greater participation and effort than one prolonged two-month season. The July season typically draws heavier hunter participation than the January season as the grasses are shorter and less dense and the birds more active at that time of year.

In FY 1985, 467 hunting licenses were sold, down 7.7% from FY 1984 levels. A hunter questionnaire was mailed out to 141 license buyers, of which 27 (19%) were completed and returned. Responses by those returning the questionnaire provided the following information on francolin hunting and harvest.

Black Francolin hunting did not draw as large a hunter participation as did the big game seasons with 33% of the active hunters reporting they hunted francolin in FY 1985, 20% during the January season and 20% during the July season (Table 1). Hunter success was 75% in both portions of the season with a harvest of 3.7 birds per hunter (5.0 per successful hunter) in January, 3.0 birds per hunter (4.0 per successful hunter) in July, and 4.5 birds per hunter (6.75 per successful hunter) over the entire season. The average harvest of 3.7 in January is surprisingly higher than the average 3.0 birds harvested in July when the grasses are shorter and the birds more active and visible.

Francolin hunters expended an average of 5.0, 4.0, and 6.0 days hunting in January, July, and over the entire season, respectively. The hunting effort expended per bird harvested was 1.33 days per bird, the same as in FY 1984.

Estimates of total hunter participation, effort, and harvest were based on the hunter questionnaires. In FY 1985, an estimated 104 hunters spent 624 hunter days and harvested 468 birds over the entire season. In contrast, 121 hunter spent 619 days hunting and harvested 463 birds in FY 1984.

Table 1. Island-wide Black Francolin (BLFR) hunt statistics for FY 1985.

	Jan 85	Jul 85	Total
a. Total license sales for year.			467
b. Hunter questionnaires mailed out			141
c. Number of hunter questionnaires returned			27
d. Percent of license buyers reporting			19.1%
e. Number of reporting license buyers that hunted any species			20
f. Percent of license buyers that hunted FY 85			74.1%
g. Estimated total number of legal hunters FY 85			346
h. Number of reporting hunters that hunted BLFR	4	4	6
i. Percent of reporting hunters that hunted BLFR	20%	20%	30%
j. Number of successful BLFR hunters	3	3	4
k. Hunter success	75%	75%	67%
l. Number of BLFR taken by reporting hunters	15	12	27
m. Average number of BLFR taken per hunter	3.7	3.0	4.5
n. Average number of BLFR taken per successful hunters	5.0	4.0	6.75
o. Estimated total number of legal BLFR hunters	69	69	104
p. Estimated total legal BLFR harvest	255	207	468
q. Reported number of days spent hunting	20	16	36
r. Average number of days spent hunting	5.0	4.0	6.0
s. Estimated total number of days spent hunting	345	276	624
t. Number of days spent hunting per BLFR taken (r ÷ o)	1.35	1.33	1.33
u. Number of BLFR taken per day hunting (o ÷ r)	0.74	0.75	0.75

Dandan was once again the most popular area in which to hunt francolin. The Bolanos Conservation Reserve, Nimitz Hill, Ordot, and Ija areas were also listed as hunting areas.

Hunters were also asked about their hunting habits. No one reported taking a daily limit of 5 birds during the season nor did anyone report using a bird dog to hunt. The hunters reported they hunted an average of 4.0 hours per day. Seven birds were reported as shot and lost versus the 27 harvested, a crippling loss of 26%. A crippling loss of 38% was reported in FY 1984.

The estimated hunter participation, effort, and harvest seemed far higher than actual francolin hunting activity. The hunter questionnaire derived figures seemingly greatly over-estimated the actual hunter participation, effort, and harvest. The inflated estimates can probably be traced to the fact that successful hunters report their hunting history more readily than unsuccessful hunters. Consequently, responses of successful hunters are over-represented in the survey of hunter activities.

Call Count Surveys

Monthly call count surveys were conducted in the Dandan areas from May 1983 through June 1985 (Table 2). To evaluate a change in francolin numbers, the counts from May 1983 to April 1984 (FY 83-84) were compared to the counts from May 1984 to June 1985 (FY 84-85). The overall mean number of calling birds per station decreased slightly from the FY 83-84 value of 5.7 birds to 5.3 birds in the FY 84-85 period. Even though the mean dropped slightly, no significant difference was detected in counts between the 2 periods (Mann-Whitney U-Test, $U=342.5$, $P>0.50$).

Dandan continues to support high numbers of francolin. The highest single count in the Dandan area, 9.8 birds per station, occurred during January 1985. The Dandan area francolin population, which receives the greatest hunting pressure, appears to have stabilized and can support hunting pressure at its present level.

RECOMMENDATIONS

1. Conduct spring calling bird surveys to monitor francolin population status and distribution.

LITERATURE CITED

Aquatic and Wildlife Resources Division. 1984. Job Progress Report - Federal Aid to Fish and Wildlife Restoration. Guam Dept. of Agriculture.

Sokal, R.R. and F.J. Rohlf. 1981. Biometry. W.H. Freeman Company. San Francisco. 859p.

Report prepared by Paul J. Conry

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Terrritory of Guam

PROJECT NO.: FW-2R-22
SUB-PROJECT NO.: W-4
STUDY NO.: 1
JOB NO.: 3

JOB TITLE: Survey and Inventory of the Native Land Birds on Guam.

PERIOD COVERED: October 1, 1984 to September 30, 1985.

SUMMARY

The decline of the native avifauna of Guam continued as shown by roadside counts, transect counts and rail surveys. Only a single Guam Rail was located in the last remaining area known to have a continuous population on the flightline at Andersen Air Force Base in northern Guam. The center of distribution of the remaining native forest birds on Guam is the Conventional Weapons Storage Area and Northwest Field on Andersen Air Force Base in Northern Guam.

BACKGROUND

Since the early 1960's, census data has documented the decline in both range and numbers of Guam's native land birds. Roadside counts initiated in 1960 over three routes in central and northern Guam by the Guam Division of Aquatic and Wildlife Resources (GDAWR) have provided an index to the decline (GDAWR, 1974-1984). From 1979 to 1981 estimates of the population size were made by the GDAWR based on variable circular plot techniques (Reynolds et al. 1980) and from station counts in central and northern Guam (GDAWR, 1980-1982). From June to July of 1981, an intensive forest bird survey utilizing variable-circular plot techniques along randomly located transects were conducted by the U.S. Fish and Wildlife Service with the cooperation of the GDAWR (Engbring and Ramsey, 1984). Some of these transects have been repeated in recent years by the GDAWR (1982).

Native land birds are now primarily restricted to northern Guam with the center of distribution of native forest birds located on Northwest Field at Andersen Air Force Base (AAFB). Exceptions are the the Vanikoro Swiftlet (restricted apparently to one known cave in central Guam), Mariana Gallinule (found over most of Guam in restricted and declining wetlands), Micronesian Starling (also found on Cocos Island), and the Yellow Bittern (declining but still found in savannah and second-growth vegetation over the entire island (GDAWR, 1974-1984).

A captive breeding program for the Guam Rail and Guam subspecies of the Micronesian Kingfisher was successfully begun in 1983. The Guam Rail is now breeding in captivity in Guam and at the Bronx Zoo and the Conservation and Research Center (CRC) of the National Zoological Park, in Front Royal, Virginia. The Kingfisher is now found in captivity at six zoos on the mainland, and bred successfully for the first time at the Bronx Zoo, Philadelphia Zoo and CRC during the summer 1985.

OBJECTIVES

To monitor population trends of the native land birds on Guam.

PROCEDURES

1. Roadside counts were conducted at bi-weekly intervals on three routes in northern Guam (Figure 1). These routes were driven at approximately 6-9 km per hour beginning at sunrise. Numbers and species of all birds seen or heard were recorded, irrespective of the distance from the observer.

2. The Pajon Basin (East Ritidian Point) variable circular plot transect was surveyed by GDAWR personnel in January, 1985(Figure 2). This transect has been run on an irregular basis since September of 1981. Prior to censusing, personnel received training in distance estimation and species identification to ensure comparable data collection. Stations were premarked and placed 150 m apart along the transects to minimize the possibility of observing the same birds from different stations. Stations were censused using the eight minute variable circular-plot techniques as described by Reynolds et. al. (1980).

3. Frequent surveys for Guam Rails using tape recorded playbacks of their calls were conducted in the flightline area in the AAFB area that in 1984 had the last known population (GDAWR, 1984).

RESULTS

Roadside count results are shown in Tables 1, 2, 3. On the North roadside count (Figure 1, Table 1), only one sighting each was made for the Micronesian Kingfisher and Cardinal Honeyeater while three Marianna Crows were counted. The only other native bird observed was the Yellow Bittern. On the North-central rosdside count (Figure1, Table 2), the Micronesian Starling with 5 individuals sighted in April, 1985, was the only native forest bird recorded. The Yellow Bittern was the only other native bird observed. Northwest Field roadside count (Figure 1, Table 2) showed a decline in all native forest birds observed as compared to FY 1984. The Rufous-fronted Fantail and Cardinal Honeyeater were not seen for the first time and only one Guam Rail was sighted.

A single transect census was done at Pajon Basin (Figure 2, Table 4) in January, 1985. The results show a continuation of the decline in this area which in 1983 was the last area on Guam to have the complete ensemble of all native forest birds present (GDAWR, 1983). Only three native forest birds were observed. The kingfisher and starling were observed in very low numbers with the crow being the only species observed at or near it's recently known density. The White-throated Ground-Dove and Cardinal Honeyeater were not observed for the first time during this census. More recent observations by GDAWR staff indicate that the Mariana Crow is now the only native forest bird still found in Pajon Basin. Northwest Field and Conventional Weapons Storage Area (CWSA) on AAFB are the primary locations for the remaining native forest birds on Guam. Survey work done by Sam Marshall of the New York Zoological Society (pers. comm.) on Micronesian Kingfishers in early summer 1985, using playback of tape recorded calls, located six pairs and several more individual males in this same area, with CWSA being the center of it's remaining distribution.

Rail census work using playback of tape recorded calls continued in the flightline area of AAFB, the last known area on Guam to have a population. By July,1985, only one rail could be located in the area that in FY 1984 contained approximately 20 individuals. Efforts at capturing rails for captive breeding purposes were suspended in July, 1984.

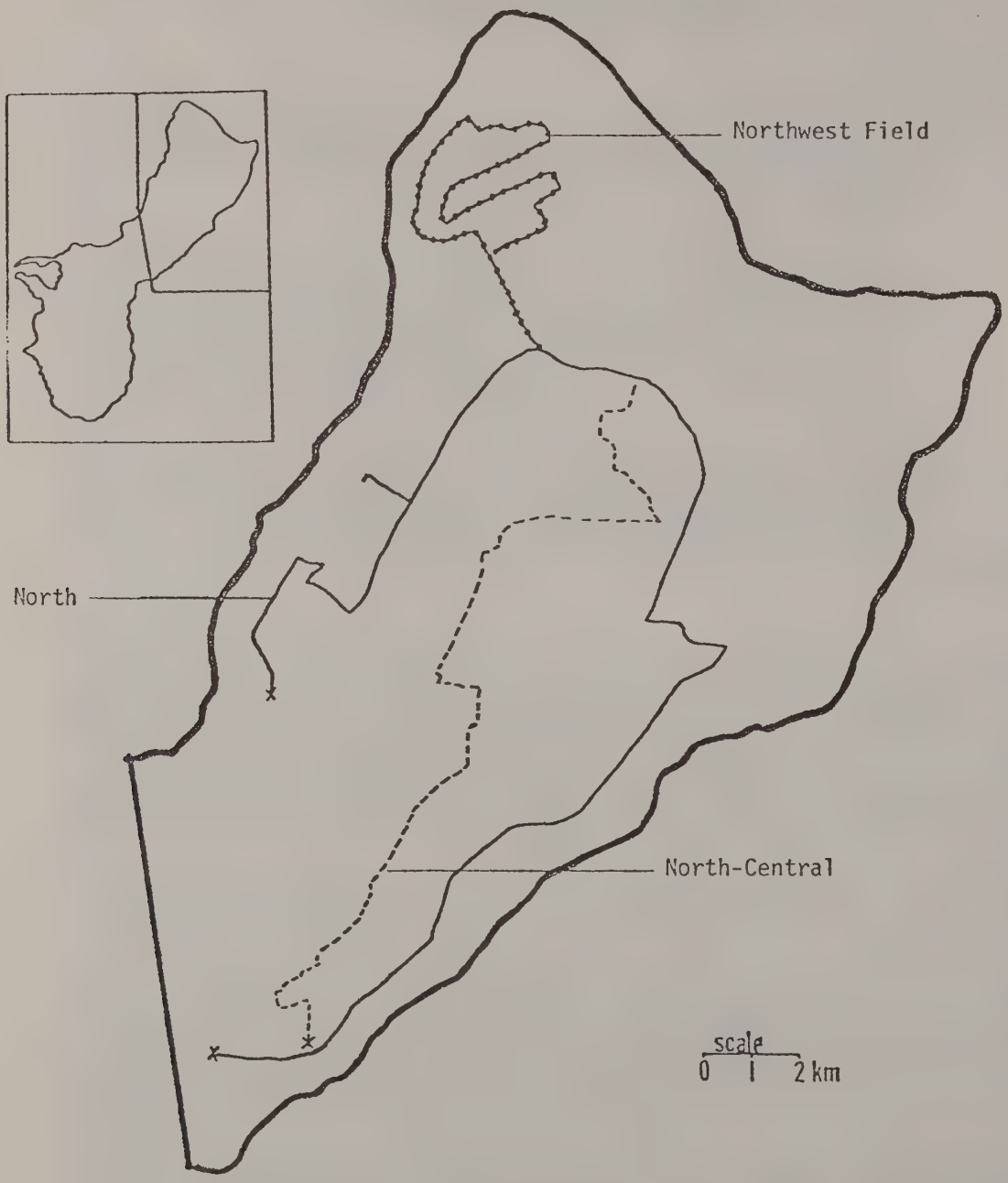

Figure 1. North, North-Central and Northwest Field roadside bird census routes along paved and unpaved roads.

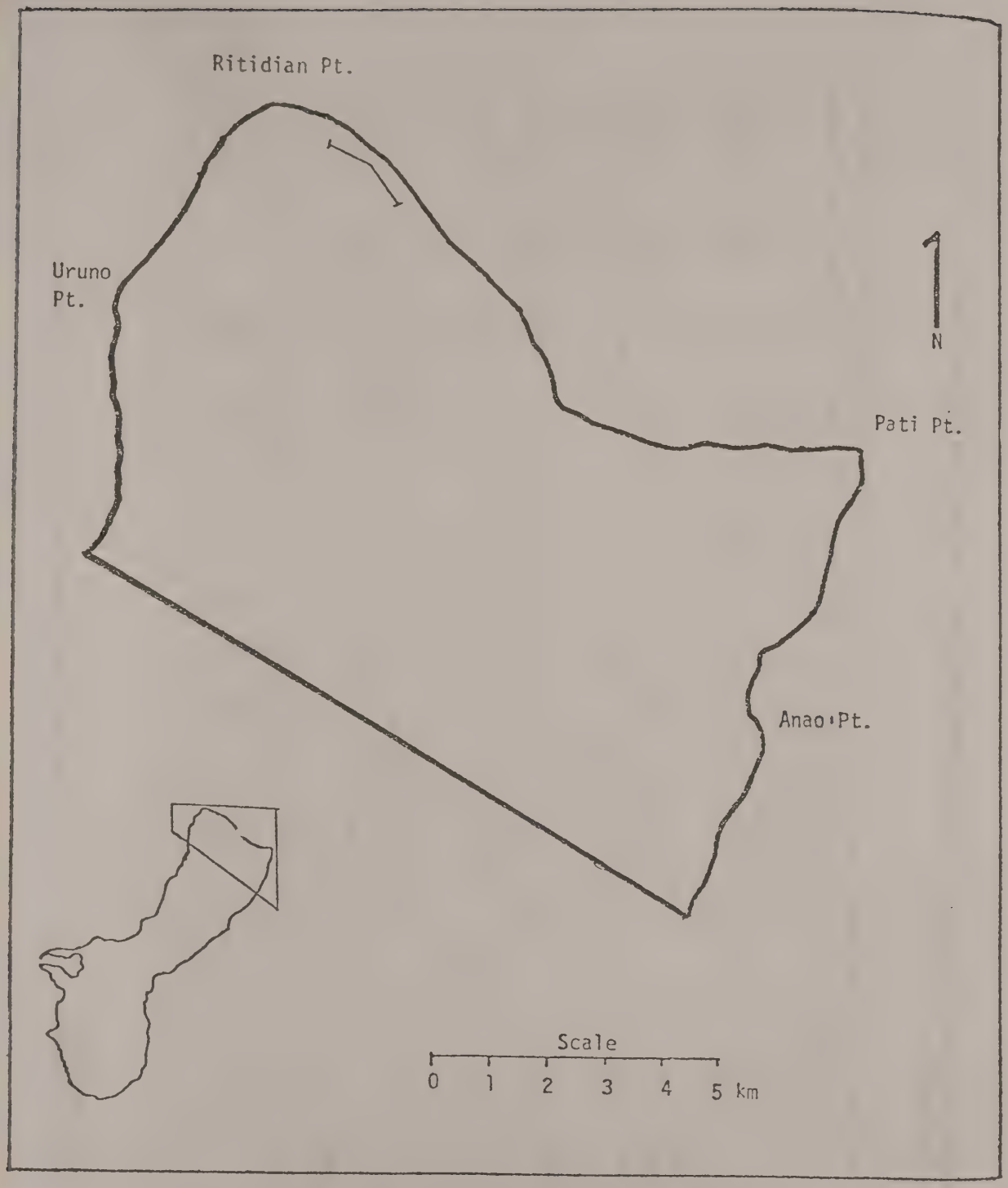

Figure 2. Location of Pajon Basin (East Ritidian Point) transect.

Table 1. Average numbers of birds per 100 km observed each month on the North roadside count during Fiscal Year 1985.

SPECIES	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOTAL	$\bar{X}$/COUNT	$\bar{X}$/100 km
Yellow Bittern	8.7		2.5	2.5	5.4					9.5	7.3	2.5	19	0.9	2.3
Mariana Crow			7.5										3	0.1	0.4
Black Drongo	23.5		22.5	14.2	2.7	7.3	4.3	7.5	2.3	14.3	15.9	14.8	103	4.9	12.2
Rufous-fronted Fantail															
Mariana Fruit-Dove															
Guam Broadbill															
Golden Plover	76.5		9.0	21.7	81.1	97.6	58.6	67.5	9.3			30.9	414	19.7	49.1
White-throated Ground-Dove															
Cardinal Honeyeater						1.2							1	0.0	0.1
Micronesian Kingfisher					2.7								1	0.0	0.1
Brown Noddy Tern															
Philippine Turtle-Dove	13.9		10.0	1.67	10.8	7.3	3.3	2.5	7.0	11.9	2.4	6.2	53	2.5	6.3
Chinese Painted Quail															
Guam Rail															
Chestnut Mannikin															
Eurasian Tree Sparrow			17.5		10.8	12.2	5.0	18.6				8.6	42	2.0	5.0
Micronesian Starling															
White Tern	3.5												4	0.2	0.5
Km	115.4		40.2	120.7	36.7	82.2	120.7	79.8	42.6	42.2	81.9	81.1	843.6		
Miles	71.7		25.0	75.0	22.8	51.1	75.0	49.6	26.5	26.2	50.9	50.4	524.2		
Counts	3		1	3	1	2	3	2	1	1	2	2	21		

Table 2. Average number of birds per 100 km observed each month on the North-Central roadside count during Fiscal Year 1985.

SPECIES	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOTAL	$\bar{X}$/COUNT	$\bar{X}$/100 km
Yellow Bittern				2.7	2.4	2.3	4.8	4.8	2.4			2.6	9	0.5	2.4
Mariana Crow															
Black Drongo	40.5			32.4	29.3	14.0	27.4	38.1	9.8	15.8	70.0	31.6	117	6.2	30.9
Rufous-fronted Fantail															
Mariana Fruit-Dove															
Guam Broadbill															
Golden Plover	705.4			235.1	492.7	123.3	340.3			5.3		257.9	913	48.1	240.8
White-throated Ground-Dove															
Cardinal Honeyeater															
Micronesian Kingfisher															
Brown Noddy Tern															
Philippine Turtle-Dove	54.0			35.1	29.3	25.6	43.5	47.6	31.7	21.1	55.0	42.1	148	7.8	39.0
Chinese Painted Quail															
Guam Rail															
Chestnut Mannikin								14.3					3	0.2	0.8
Eurasian Tree Sparrow	43.2			16.2	7.3	4.7	3.2	47.6	29.2	89.5	27.5	21.1	87	4.6	22.9
Micronesian Starling							8.1						5	0.3	1.3
White Tern				18.9									7	0.4	1.8
Km	36.7			36.7	41.0	42.5	62.4	21.0	41.7	18.8	40.9	37.5	379.2		
Miles	22.8			22.8	25.5	26.4	38.8	13.1	25.9	11.7	25.4	23.3	235.6		
Counts	2			2	2	2	3	1	2	1	2	2	19		

Table 3. Average number of birds per 100 km observed each month on the Northwest Field roadside count during Fiscal Year 1985.

SPECIES	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOTAL	$\bar{X}$/COUNT	$\bar{X}$/100 km
Yellow Bittern	7.6			5.3	5.5			2.5	5.4		10.5	2.7	13	0.7	3.7
Mariana Crow	17.0			28.9	38.9	28.9	9.1	25.7	18.9	26.3	59.5	94.7	100	5.3	28.6
Black Drongo	473.6			592.1	261.1	282.7	249.0	197.5	345.9	263.2	381.0	447.4	1290	67.9	369.0
Rufous-fronted Fantail															
Mariana Fruit-Dove					11.1								2	0.1	0.6
Guam Broadbill															
Golden Plover	22.6			13.1	55.6	13.5	1.8				13.5	115.8	61	3.2	17.4
White-throated Ground-Dove				5.3									2	0.1	0.6
Cardinal Honeyeater															
Micronesian Kingfisher	1.9			13.1	11.1	9.6	3.6	2.5					16	0.8	4.6
Brown Noddy Tern															
Philippine Turtle-Dove	130.2			89.5	15.0	46.2	145.5	322.5	159.5	126.3	197.3	210.5	559	29.4	159.9
Chinese Painted Quail															
Guam Rail	1.9												1	0.1	0.3
Chestnut Mannikin									8.1				3	0.2	0.9
Eurasian Tree Sparrow	9.4						7.3						1	0.2	0.3
Micronesian Starling				23.6	16.7					21.1			21	1.1	6.0
White Tern				13.2									5	0.3	1.4
Km	52.9			38.1	18.2	34.3	54.5	40.4	37.0	18.7	36.5	18.8	349.6		
Miles	32.9			23.7	11.3	21.3	33.9	25.1	23.0	11.6	22.7	11.7	217.2		
Counts	3			2	1	2	3	2	2	1	2	1	19		

Table 4. Results of Northwest Field, North, and North Central roadside counts showing the mean number of birds per 100 Km of travel, the sandard deviation (σ) and the coefficient of variation (CV).

Species	Northwest Field FY			North FY			North-Central FY		
	$\bar{X}$	σ	CV	$\bar{X}$	σ	CV	$\bar{X}$	σ	CV
Yellow Bittern	3.7	3.2	85.8	2.2	2.7	123.0	2.5	1.5	59.1
Mariana Crow	27.1	22.3	82.2	0.4	1.6	62.6	0.0	0.0	0.0
Black Drongo	354.6	120.5	34.0	12.3	6.9	56.7	31.1	16.2	52.3
Rufous-fronted Fantail	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Mariana Fruit-Dove	0.6	2.5	424.3	0.0	0.0	0.0	0.0	0.0	0.0
Golden Plover	17.1	26.7	156.3	49.6	32.6	65.66	245.0	225.0	91.8
White-throated Ground-Dove	0.6	1.6	291.5	0.0	0.0	0.0	0.0	0.0	0.0
Cardinal Honeyeater	0.0	0.0	0.0	0.1	0.4	308.2	0.0	0.0	0.0
Micronesian Kingfisher	4.1	4.5	110.7	0.1	0.6	447.2	0.0	0.0	0.0
Brown Noddy Tern	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Philippine Turtle-Dove	147.8	78.3	53.0	6.3	4.3	68.1	39.2	10.6	26.9
Chinese Painted Quail	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Guam Rail	0.3	0.7	230.9	0.0	0.0	0.0	0.0	0.0	0.0
Chestnut Mannikin	0.9	2.5	391.5	0.0	0.0	0.0	.8	3.2	424.3
Eurasian Tree Sparrow	2.6	3.9	148.9	4.9	6.1	123.6	23.4	21.0	89.7
Micronesian Starling	6.0	8.7	145.5	0.0	0.0	0.0	1.3	3.0	230.9
White Tern	1.4	4.1	291.5	0.5	1.2	244.9	2.0	5.8	291.5

Table 5. Forest birds seen at Pajon Basin on transect counts. Numbers are average total number of birds counted by 2 observers at ten stations at Pajon Basin (East Ritidian Pt.), Guam from September 1981 to January 1985.

Species	DATE										
	6/18/81*	6/2/82	5/19/83	6/28/83	7/28/83	8/31/83	9/30/83	10/27/83	12/5/83	5/15/84	1/29/85
Guam Rail	0	0	0	0	0	1.0	0	0	0	0	0
Mariana Fruit-Dove	5.5	9.5	2.0	1.0	1.0	2.0	0	0	0	0	0
Philippine Turtle-Dove	0	0	0	3.0	2.5	15.5	21.5	10.5	17.0	9.5	0.5
White-throated Ground-Dove	.5	1.5	4.5	1.0	0	4.0	1.5	1.5	1.5	2.5	0
Micronesian Kingfisher	14.5	8.5	12.0	23.0	18.0	15.5	18.0	9.5	20.0	13.0	2
Mariana Crow	14	16.5	18.6	28.0	25.5	25.0	20.0	26.5	32.5	18.0	25.5
Rufous-fronted Fantail	36.5	27.5	22.0	21.5	6.0	2.0	2.0	1.5	0	0	0
Guam Broadbill	3.0	11.5	2.5	8.5	10.5	8.0	6.0	1.0	0	0	0
Micronesian Starling	76.0	79.5	71.5	63.0	75.0	61.0	48.5	51.0	41.0	35.5	3.5
Cardinal Honeyeater	15.5	16.5	15.5	17.0	17.0	9.0	9.5	15.0	4.0	1.0	0
Bridled White-eye	54.0	49.0	1.5	0	0	0	0	0	0	0	0

*1981 survey was conducted by U.S.F.W.S. and DAWR staff. 1982 to 1985 survey was conducted by DAWR staff.

RECOMMENDATIONS

1. Continue bi-monthly roadside counts over the three routes in northern Guam.
2. Continue playback census of the Guam Rail in it's remaining range.
3. Initiate a yearly census of the Mariana Crow in order to estimate population size on Guam.
4. Establish a working agreement with the Division of Fish and Game, Commonwealth of the Northern Mariana Islands to monitor the population size of the Mariana Crow on Rota.
5. Develop and implement methods for control of the brown tree snake.
6. Continue efforts to captive endemic endangered native land birds on Guam and at stateside zoos.
7. Continue natural history and breeding biology studies of the native avifauna.

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Report prepared by: Robert E. Beck, Jr.

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-22
SUB-PROJECT NO.: W-5
STUDY NO.: 1
JOB NO.: 2

JOB TITLE: The Current Status, Distribution and Natural History of Marianas Fruit Bats.

PERIOD COVERED: October 1, 1984 to September 30, 1985.

SUMMARY

Guam's fruit bat population is currently estimated at 695 to 800 animals. Bat colonies were observed at six roosts during the year, with five of these located at Pati Point. One poaching incident and one unsuccessful attempt are known to have occurred during the year. In FY 1985, 10,084 frozen fruit bats were imported to Guam from other islands for human consumption, a decrease of 37.9% from the previous year. A recovery plan for fruit bats on Guam was written during the year and describes future recovery efforts that should be made.

BACKGROUND

The Marianas fruit bat (*Pteropus mariannus mariannus*) is endemic to the Mariana Islands and has been under investigation by the Division of Aquatic and Wildlife Resources (DAWR) of Guam since 1962 (DAWR 1964-1984). These bats, considered a delicacy by Chamorro residents, steadily declined in number during the 1960's (Perez 1972). Thereafter, annual surveys revealed that only a few dispersed, solitary bats remained in the prime habitat on Guam which once supported colonies containing hundreds of bats (Wheeler and Aguon 1978, Wheeler 1979). Reasons for the decline included: increased human population pressures that resulted in over-hunting and permanent habitat destruction, commercial exploitation of this food species, periodic severe typhoons, the lack of an adequate enforcement staff, and delays by the local legislature in passing protective legislation (Wheeler 1979). The Marianas fruit bat and the little Marianas fruit bat (*P. tokudae*) finally received full protection from hunting in 1973. Both species were placed on Guam's territorial Endangered Species List in 1981 and on the U.S. Endangered Species List on August 27, 1984. Marianas fruit bat abundance began to increase in 1980 and by 1982, Guam's population had grown to an estimated 850 to 1,000 animals. However, by 1984, poaching had caused numbers to fall to about 400 to 470 animals.

OBJECTIVES

To monitor the population size and study the natural history of Marianas fruit bats in the Mariana Islands.

PROCEDURES

1. Continue the systematic survey of fruit bat distribution and numbers initiated on Guam in 1978 and in the Commonwealth of the Northern Mariana Islands (CNMI) in 1979.

    a. Conduct annual surveys of Guam's northern cliffline with periodic surveys in other areas.

        1. Record bat numbers observed and search for additional bat colonies.

        2. For each bat observed record (where possible and applicable) flight elevation and direction, roosting tree species and height, part of plant eaten (flower, fruit, leaves, etc.), height in forage tree, sex and age (if possible), other behavior such as vocalization, copulation, etc.

    b. Conduct weekly intensive observations of bat colonies.

2. Determine habitat use of fruit bats.

    a. Record roosting sites of bat colonies.

    b. Visit abandoned colony roosting sites and record the size and abundance of the vegetation present.

3. Monitor fruit bat imports to Guam from other islands in Micronesia and the Pacific.

4. Investigate illegal hunting of fruit bats.

    a. Visit abandoned roosting sites of colonies to determine illegal hunting effort.

    b. Assist Conservation Officers with investigations of bat poaching.

RESULTS

Sizes and Locations of Bat Colonies on Guam

Colonies of Marianas fruit bats were observed at six roost sites during FY 1985, with five of these roosts located on Pati Point (Table 1, Figure 1). Three roosts were used for periods of several months or more dating back to previous years. North Pati Point (Site 1) was occupied until early June 1985 when poachers visited the site and caused it to be abandoned. Fruit bats had resided at this locality since late June 1981, a period of 47.5 consecutive months (DAWR 1981-1984). During FY 1985, counts of bats at this roost increased from 302 animals in October to 470 animals in March and May (Table 2).

The increase in the size of the bat colony at North Pati Point (Site 1) can probably be partially explained by the gradual reduction in numbers of bats at the roost at East Ritidian Point. This second roost existed from 1 July to about 1 November

Table 1. Approximate dates of use of six roost sites by colonies of Marianas fruit bats on Guam.

Site	Approximate period of use by bats
North Pati Point - Site 1	24 June 1981 to 10 June 1985
East Ritidian Point	1 July 1984 to 1 November 1985
North Pati Point - Site 2	10 to 17 June and 21 to 22 June 1985
East Pati Point	10 to 17 June 1985
North Pati Point - Site 3	18 June 1985 to present
North Pati Point - Site 4	19 June 1985

Table 2. Counts of Marianas fruit bats at six roosts on Anderson Air Force Base, Guam in FY 1984 and FY 1985.

	North Pati Point				East Pati	East Ritidian
Date	Site 1	Site 2	Site 3	Site 4	Point	Point
11 Sept FY 84	322	-	-	-	-	71
15 Oct FY 85	302	-	-	-	-	+
16 Oct	300	-	-	-	-	+
19 Nov	368	-	-	-	-	-
29 Nov	392	-	-	-	-	-
15 Jan	431	-	-	-	-	-
15 Feb	437	-	-	-	-	-
9 Mar	470	-	-	-	-	-
17 Apr	427	-	-	-	-	-
9 May	470	-	-	-	-	-
12 June	0	120	-	-	+	-
19 June	0	0	+	+	0	-
20 June	100-200	0	-	0	-	-
21 June	0	20	-	0	0	-
24 June	126	0	75	0	-	-
25 June	50-75	0	145	0	-	-
28 June	0	0	281	0	-	-
31 July	0	0	391	0	-	-
13 Aug	0	0	459	0	-	-
27 Sept	0	0	527	0	-	-

\+ = Bats present at roost but no counts made.
\- = No counts made.

Figure 1. Locations of six roost sites used by Marianas fruit bats in FY 1985.

1984 and slowly decreased in size from 150 to 70 individuals by September (Tables 1, 2). It seems likely that most bats departed this roost and joined the colony at North Pati Point (Site 1) where increases in the number of bats were noted in November (Table 2).

After poachers attacked the roost at North Pati Point (Site 1) in early June, the colony apparently separated into several groups, two of which remained on Pati Point. These two groups moved among four different roosts (North Pati Point, sites 2, 3, and 4, and East Pati Point) during the following $2\,^1/_2$ to 3 weeks (Table 2). Both groups appeared to join and then re-separate at least once with some individuals undoubtedly intermingling between groups. The two groups finally joined permanently by 28 June and began residence at North Pati Point (Site 3) with approximately 281 bats present. The long length of time involved in re-establishing a permanent colony was unusual. After past poaching incidents, colonies have normally established new roosts within 1 to 4 days. In this example at Pati Point, additional human disturbance was not known to have occurred. However, a possible explanation could involve 15 to 40 kph winds that blew from the south and southeast during much of June. These winds may have caused the bats to feel uneasy at most roosting sites and caused to search for sites until one site was found that was relatively protected from the winds.

As in previous years, the fidelity of fruit bats to former roosting sites was low. Only one (North Pati Point - Site 1) of the six sites occupied in FY 1985 has been used previously during the last four years. The roost at East Pati Point that was used briefly in June 1985 was located approximately 150 m south of a roost used by bats for 9 days in June 1981.

Surveys of Fruit Bats on Guam

Censuses of fruit bats at colonies ranged from less than 100 to 527 animals, with the highest count occurring in September (Table 2). An estimate of the island's population of fruit bats was determined using the September count. Because some individuals were probably hidden by thick foliage, the total number of adults in the colony was likely to be 10 to 20% higher than the actual number counted. In addition, approximately 65% of the adults in the colony were harem females, with approximately 11% of these animals possessing unweaned young (see Natural History). These figures provide an estimate of 580 to 630 adults and 40 to 45 juveniles, or a total of 620 to 675 bats, within the colony at the end of the year.

Reports of observations of solitary fruit bats were obtained during the year from Northwest Field and the Conventional Weapons Storage Area on AAFB (5 sightings), Route 3 in Dededo approximately 2 km northeast of Wettengel Junction (1 sighting), the Marine Lab at the University of Guam (1 sighting), Route 15 near the Hawaiian Rock quarry in Mangilao (1 sighting), and west of Mt. Alifan on Naval Magazine (1 sighting). Aside from the colony at Pati Point, an estimated 50 to 75 fruit bats are believed to live solitarily or in small groups along the island's northern cliffline that extends from Bijia Point to Iates Point. An additional 25 to 50 animals probably inhabit Naval Magazine, Talofofo and Malojloj. Based on these figures, Guam's island-wide population of fruit bat is estimated to contain 695 to 800 animals. This amount is higher than the FY 1984 estimate of 400 to 470 animals (DAWR 1984).

The source of the island's increase in fruit bats during FY 1985 is unknown. Maturation of young bats at the Pati Point colony appears to be extremely low (see Natural History), thus, it seems doubtful that natural recruitment could account for the population's increase. This year's increase in bats may have resulted from animals traveling to the island from Rota. Fruit bats may fly solitarily or in relatively small groups between the two islands, causing their slowly increasing numbers at Pati Point to go unnoticed during monthly counts. Further evidence for inter-island movements of bats was gathered in 1985 by personnel from the CNMI Division of Fish and Wildlife. In July, a small colony of 35 to 50 bats was observed on Aguijan (D.T. Aldan, pers. comm.), which previously held a small population estimated at less than 10 animals (Lemke 1984). This new colony probably arrived from Rota, which lies about 75 km south of Aguijan, rather than from nearby Tinian or Saipan, each of which possesses probably less than 25 bats (Lemke 1984). Thus, it appears that small numbers of fruit bats do indeed travel between Rota and other neighboring islands.

Natural History

Social Organization - Adult sex ratios of 72.7 males:100 females (n = 475 at Site 1) in November 1984 and 53.4 males:100 females (n = 500 at Site 3) in August 1985 were recorded for bats roosting in the colony at North Pati Point. These compare with an adult sex ratio of 37.5 males:100 females (n = 77) that was previously noted at North Pati Point (Site 1) in FY 1982 (DAWR 1982).

Bats roosting in harems comprised 69% of the colony at North Pati Point in December 1984 and 74% of the colony in August 1985. During these same observations, groups of bachelor males made up 22% and 21% of the colony, respectively. Solitary males found on the periphery of the colony comprised 8% of the bats present in December and 5% in August.

Reproduction - During FY 1985, 54 to 101 harem females were identified monthly at North Pati Point (Sites 1 and 3) and examined visually through a spotting scope for the presence of unweaned young. Females with young comprised 9.0 to 19.5% of the females identified (Table 3). There did not appear to be a seasonal peak in the birth of young. Most (72%) of the juveniles observed were judged to be small-sized; no large young were noted during the year. The decline in the abundance of older-aged juvenile fruit bats at the colony indicates that young animals may not be maturing to breeding age. This may be a result of heavy predation by brown tree snakes (*Boiga irregularis*).

Predation - Two attempts were made to measure the abundance of brown tree snakes in the vicinity of the bat roost at North Pati Point (Site 1) after the location was abandoned in early June. This site was chosen instead of an active colony to avoid disturbing roosting bats. Four observers conducted a visual search for snakes from 2030 to 0100 on 11-12 July and found four snakes within 100 m of the former roost trees. From 11 to 22 July, 16 baited funnel traps were placed in low branches and on rock outcrops within 20 m of the former roost trees. In traps baited with live quail, a single snake was captured during 33 trap-nights, however, no animals were caught in traps baited with chicken droppings during 143 trap-nights. In addition, a sixth snake was recorded at the site on 19 June; it was observed 6m high in an *Aglaia marianennsis* tree located within 10 m of the former roost trees. All of these snakes were 100 to 150 cm long.

Table 3. Number of harem females observed with unweaned young at North Pati Point from October 1984 to September 1985.

	No. of Females observed	No. of Females w/o young	No. of Females w/ small young	No. of Females w/ medium young	No. of Females w/ large young	% of Females with young
Oct	82	68	10	6	0	19.5
Nov	78	66	7	5	0	15.4
Dec	65	58	3	4	0	10.8
Jan	82	68	12	2	0	17.1
Feb	84	72	8	4	0	14.3
Mar	101	85	11	5	0	15.8
Apr	73	65	5	3	0	11.0
May	89	81	7	1	0	8.0
Jun	54	45	9	0	0	16.7
Jul	74	62	10	2	0	16.2
Aug	74	65	8	1	0	12.2
Sept	97	86	7	4	0	11.3
TOTAL	-	-	97	37	0	14.1

Bat Imports

During FY 1985, 66,149 fruit bats were requested for import (Table 4), a decrease of 20.2% from the previous year (DAWR 1984). A total of 10,084 frozen fruit bats in 83 shipments were actually shipped to Guam from other islands in FY 1985 (Table 5). This represents a decrease of 37.9% over the previous year and is the first decline in imports since FY 1982. The 10,084 bats brought to Guam is the smallest amount for a single year since FY 1975, when approximately 8,200 animals were imported (DAWR 1976)..

Western Samoa was the major source of bats for the Guam market in FY 1985, accounting for 71% of all imported bats (Table 5). This country has been the primary supplier of bats during each of the last three years, averaging 7,400 bats per year. Islands within Micronesia shipped 2,044 fruit bats to Guam (20% of the total). Only 1,458 bats were imported from Palau in FY 1985, a decline of 64% from the previous year. Tonga and Papua New Guinea, two important exporting countries in FY 1984, failed to send any bat shipments to Guam in FY 1985. Direct airline flights between Papua New Guinea and Guam were not scheduled during most of the year and, thus, prevented fruit bat shipments from being made. Two retailers imported 71% of all animals brought to the island, with nearly all of their shipments coming from Western Samoa. They accepted 5,769 and 1,387 animals from exporters (57% and 14% of all animals imported), respectively.

Ninety-one bats came into Guam from Saipan in FY 1985. All of these animals were certified by the CNMI government as having come originally from American Samoa (85 bats) or Palau (6 bats). In addition, T.O. Lemke (pers. comm.) learned from reliable sources in the CNMI that unknown numbers of fruit bats were smuggled into Guam from Rota on small boats in 1984 and early 1985.

During FY 1985, a manuscript describing the fruit bat trade on Guam was accepted for publication in Biological Conservation.

Illegal Hunting

Poaching continues to be a major factor preventing the recovery of Guam's fruit bat population. One known case and one attempt to hunt bats were recorded in FY 1985. Between 1 and 10 June, hunters visited the colony roost at North Pati Point (Site 1), causing the bats to abandon the site. During a visit to the empty roost on 12 June, 15 fresh shotgun shells were collected. Thirteen of the shells were found next to the main set of roosting trees while two others were discovered about 100 m away below a cliffside. This small number indicates that the number of bats killed may have been relatively low.

A poaching attempt was witnessed at the same location on 16 July. At 1020, three men were observed anchoring a motor boat about 30 to 40 m from the north shore of Pati Point. Two of the men swam ashore while towing a rubber inner tube with a styrofoam cooler and a long shotgun-like object placed on top. The two hunters separated after landing on the shore. One man approached to within 200 m of the active colony at Northeast Pati Point while the second fired two shots from near the abandoned roost site. The men returned to the boat after about 1.5 to 2 hours and departed the area. Conservation Officers intercepted the craft at the Agana Boat Basin and found a 12-gauge shotgun with 40 to 50 shells. About 75% of the shells contained No. 6 shot while the remainder held 00B shot and slugs. Although no

Table 4. Number of frozen fruit bats requested for import to Guam between October 1, 1984 and September 30, 1985.

	Western Samoa	American Samoa	New Guinea	Palau	Ponape	Truk	Kosrae	Cook Islands	Total
Oct	2,000	2,450	2,000	460	400	200			7,510
Nov	4,000	2,650	2,500	170	620		50		9,990
Dec	50			314	250		50		664
Jan	2,000	1,200	1,000	530	74				4,604
Feb	4,000	3,250	1,000	745		100			9,095
Mar	4,400	300		495	35			100	5,330
Apr	3,100	600	500	225					4,425
May	2,400		2,000	680	60	50			5,190
Jun	3,000			1,206	50				4,256
Jul	400			306	62	100			868
Aug	3,800			1,482	25	50			5,357
Sept	8,000	130		360	50	100			8,660
TOTAL	37,150	10,600	9,000	6,973	1,626	600	100	100	66,149
No. of Permits Issued	72	29	18	111	22	7	2	1	262

Table 5. Number of frozen fruit bats imported to Guam from October 1, 1984 to September 30, 1985.

	Western Samoa	Palau	American Samoa	Ponape	Saipan	Truk	Total
Oct	64	50	403	25			542
Nov	900	10		200			1,110
Dec	1,086	103		50	69		1,308
Jan	500	42	200	50			792
Feb	500	55	200		12		767
Mar	350	98	50	15			513
Apr	642			8			650
May	745	100		60			905
Jun	850	601		50			1,501
Jul	850	91					941
Aug	100	233				37	370
Sep	600	75			10		685
TOTAL	7,187	1,458	853	458	91*	37	10,084
No. of Shipments Received	27	34	7	10	4	1	83

*All bats were certified by the CNMI government as having originated in American Samoa (85 bats) or Palau (6 bats).

animal carcasses were found aboard the boat, it appeared that the men had been planning to hunt fruit bats or deer.

Surf conditions at Pati Point are normally very rough throughout most of the year but were sufficiently calm from June to mid-August to allow the hunters to swim ashore safely on 16 July. It is likely that poachers also reached the colony in June by traveling to the point by boat and swimming ashore.

During the poaching investigation at North Pati Point on 12 June, 163 older shotgun shells were collected from the vicinity of the abandoned roost in addition to the 15 fresh shells found that day. Many of the older shells had deteriorated considerably and were estimated roughly to be 15 or more years old. On a previous visit in April 1981, 127 other shells were gathered from the ground in the same area. This total of 290 older shells indicates that considerable hunting has occurred at North Pati Point during the past two decades probably because the area has been a major roosting site of fruit bats during this period. Poaching has occurred there despite the remoteness of the area and its close proximity to the highly secure Weapons Storage Area of AAFB.

Recovery Plan for Guam's Fruit Bats

During the year, a recovery plan for *P. m. mariannus* and *P. tokudae* on Guam was drafted in cooperation with the U.S. Fish and Wildlife Service. The plan describes the status and natural history of both species of fruit bat on Guam as well as the reasons for their decline and conservation efforts that have already been made. In addition, the document designates objectives for a recovery program, lists a number of specific recovery actions with a tentative schedule for their implementation, and identifies lands in northern and southern Guam that should be declared as essential habitat for fruit bats. The plan underwent technical review in September 1985 and will be submitted for agency review in January 1985.

Insectivorous Bats

A manuscript describing the discovery of a bat carcass tentatively identified as *Myotis lucifugus* on AAFB (DAWR 1983) was accepted in FY 1985 for publication in the Journal of Mammalogy.

RECOMMENDATIONS

1. Survey bat numbers and distribution along Guam's entire northern cliffline once or twice annually. Searches for additional colonies may prove to be productive since continued poaching at bat roosts on Rota (T.O. Lemke, pers. comm.) could cause large numbers of bats to move to Guam.

2. Continue to make observations at Guam's bat colonies. Information should be gathered on reproductive biology, behavior within the colonies, and the sex and number of bats present.

3. Known bat roosting areas should be patrolled regularly by Conservation Officers. Part of their effort should be aimed at maintaining a visible presence at Jinapsan and Pajon Points, where poaching is a serious problem.

4. Determines the amount of predation on fruit bats by brown tree snakes (*Boiga irregularis).* The age classes of bats that are most susceptible to predation by

snakes must be investigated. The extent of predation occurring at colonies and during foraging at night should be determined.

5. Form a cooperative bat research program with the CNMI to collect information on the locations and sizes of colonies, reproductive biology and behavior within colonies. Most of the work done under this program would be conducted on Rota where a relatively large bat population is found but where logistics prevent the CNMI from doing extensive field work. Emphasis of this project would be to identify colonies should they move between Guam and Rota.

6. Continue to monitor fruit bat imports entering Guam. Export permits or certificates of origin should continue to be required for all shipments to ensure that the bats have been legally harvested, that the place of origin is known, and that the government authorities at the place of origin are aware of the drain on their resources.

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Report prepared by: Gary J. Wiles

GUAM ENDANGERED SPECIES INVESTIGATIONS
PROJECT E-1-1
Section 6 - Endangered Species Act of 1973

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: E-1-1
STUDY NO.: 1
JOB NO.: 2

JOB TITLE: Impact of *Boiga irregularis* and Other Predators on Native Bird Populations.

PERIOD COVERED: October 1, 1984 to September 30, 1985.

SUMMARY

Studies on the impact of the brown tree snake, *Boiga irregularis* on Guam's avifauna and on the ecology and biology of this snake are in progress. Research indicates *B. irregularis* is responsible for the range reduction and extinction of the forest avifauna.

BACKGROUND

Guam's native birds have declined drastically in recent decades while avian populations have remained relatively stable on other nearby islands. *B. irregularis* is the only known avian predator unique to Guam among the local islands, and its range expansion on Guam correlates with the range contraction of the forest avifauna (Savidge 1984).

OBJECTIVES

To determine the impact of predation by *B. irregularis* and other predators on bird populations and to study the ecology and biology of this snake.

PROCEDURES

1. Transects with bird-baited funnel traps were employed to determine predation pressure in various locations on Guam.

2. Distribution and abundance of alternative prey items for the snake, particularly small mammals, are being investigated.

3. Snakes are collected on a regular basis to track changes in diet as prey populations decline, to document what prey the various size classes take, to gain information on the age structure of the snake populations, and to study the reproductive biology of the species.

4. Activity patterns, diurnal retreats, and home range of *Boiga* are being determined by use of radio telemetry.

5. Nests of the Philippine Turtle-Dove were monitored to determine nesting success and causes of nest failure.

RESULTS

Research on the impact of the brown tree snake on Guam's avifauna is summarized in Savidge (1986). Data indicates *Boiga* is responsible for the decline of Guam's forest avifauna. Transects with baited funnel traps revealed high predation by snakes in areas where avian populations had been decimated and little or no predation in areas supporting healthy avian populations (Savidge 1986). *Boiga* consumes small mammals and lizards in addition to birds. Various areas that were trapped prior to snake invasion were retrapped, and field habitats showed a 94 percent decrease in numbers of small mammals (Savidge 1986). Several exotic species have also declined in a pattern similar to that of the native forest birds. Introduced Philippine Turtle-Doves *(Streptopelia bitorquata)* have declined drastically in southern Guam and nesting studies in northern Guam by P. Conry, DAWR biologist, indicate extremely low nesting success of 10 percent or below in forested habitat and 21 percent in developed areas. Conry attributed the poor nesting success largely to predation by snakes (P. Conry, in preparation).

Data gathered during snake necropsies is being entered onto the computer and will be summarized for publication. Over 700 snakes have been examined. Preliminary data on telemetry studies has been summarized by DAWR biologist, G. Wiles (Appendix A).

In July-August 1984, two herpetologists with the U.S. Fish and Wildlife Service initiated studies on Guam on possible means for controlling *B. irregularis* .

RECOMMENDATIONS

1. Continue to investigate the impact of *Boiga* on its prey.

2. Summarize and publish existing data on *Boiga's* food habits and reproductive biology.

3. Continue to investigate the life history, feeding ecology, abundance, and distribution of *Boiga* .

4. Encourage continued Federal involvement in developing control methods for *Boiga* .

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Report prepared by: Julie A. Savidge

APPENDIX A

PRELIMINARY RESULTS OF A RADIO-TRACKING STUDY OF BROWN TREE SNAKES ON GUAM

ABSTRACT: Four large male brown tree snakes (Boiga irregularis) were radio-tracked at two study sites in northern Guam in 1984. A mean of 8.3 locations was obtained for each animal. Distances between consecutive radio locations averaged 58.7 m with 86% of these movements being less than 100 m in length. Snakes used a variety of resting sites that ranged from 0 to 9 m in height; 74% of all sites were arboreal and 26% were terrestrial. The most commonly used resting sites occurred in the upper branches of small to medium-sized trees at heights of 4 to 9 m. Study animals were frequently located in vegetation along the edges of large openings, an indication that snakes may be reluctant to cross such openings. Two of the animals in the study were preyed upon by monitor lizards (Varanus indicus).

INTRODUCTION

Predation by brown tree snakes is a primary cause for the range reductions and extinctions of 10 species of native forest birds on Guam (Savidge 1986). Snakes may also be a major predator on the island's population of Marianas fruit bats (Pteropus mariannus) (Wiles in prep.). Recovery efforts for endangered birds and bats on Guam should concentrate on controlling and perhaps eventually eradicating the brown tree snake from the island. Information on the ecology and biology of Boiga irregularis will be useful in designing and implementing a control program for these animals. The use of radio telemetry will assist researchers in learning more about the species' movements, activity patterns and habitat use. In order to assess the potential of this research method, a preliminary radio telemetry study of brown tree snakes was conducted on Guam between July and November 1984.

STUDY AREA

Snakes with radio transmitters were released at two study sites on Andersen Air Force Base in northern Guam. One site was located at the intersection of the beach and firing range roads at Tarague Basin. This area was an abandoned coconut (Cocos nucifera) plantation that had been planted prior to World War II. The forest's canopy was composed mainly of mature Cocos and reached a height of 18 m. A dense understory was usually present and was comprised primarily of Neisosperma oppositifolia, Guamia mariannae, Aglaia mariannensis, short Cocos, Triphasia trifolia, Premna obtusifolia, Pandanus tectorius and the vines Alyxia torresiana and Flagellaria indica. The area also supported a high density of feral pigs (Sus scrofa).

The second study site was located along the north side of the northern runway at Northwest Field. This area contained a scrubby form of secondary limestone forest with Hibiscus tiliaceus, Casuarina equisetifolia, Leucaena leucocephala, Pandanus tectorius and Scaevola taccada being common. The canopy of this forest was 4 to 7 m tall and undergrowth was dense.

METHODS AND MATERIALS

Transmitters used in the study were SB2-IV models (AVM Instrument Co., Dublin, Calif.) with a single 1.35-volt Hg battery and 30-cm-long flexible whip antenna. The transmitter-package was potted in beeswax prior to implantation. The entire assembly was 4.5 cm long by 2 cm wide and weighed 25 g.

Snakes used in this study were originally captured by island residents at several different sites in central Guam. Animals were weighed and then anesthesized with intramuscular injections of ketamine hydrochloride. Dosage rates of 50 to 75 mg/kg were required for complete immobilzation of snakes. Injections were made in several locations along the bodies of each animal with approximately 10 mg of drug injected at each location (Speake et al. 1979). After immobilization, snakes were measured and sexed.

Procedures for implanting transmitters generally followed those described by Reinert and Cundall (1982). An incision was made through the skin between the first and second dorsal scale rows at a point anterior to the gonads (about two-thirds of the way toward the vent from the head). The transmitter was inserted through the opening into the peritoneal cavity. The antenna, which trailed posteriorly, was pushed through a 4-mm-wide, 30-cm-long piece of steel tubing that had been inserted subcutaneously and posteriorly along the side of the body. A small second cut was made at the posterior end of the tubing so that the tubing could be removed, leaving the antenna in place under the skin. Surgical stitching was used to close both wounds.

Instrumented snakes were located with a portable receiver (LA12-DS, AVM Instrument Co.) and a 3-element hand-held yagi antenna. Transmitter frequencies ranged from 216 to 217 MHz. The maximum distances that transmitter signals could be received varied from 50 to 175 m. Instrumented animals were located by rotating the hand-held antenna until the strongest transmitter signal was obtained. The investigator then walked in the direction of the signal until the animal was found. At each site, the type of vegetation used by the snake and the animal's height above the ground were recorded. Locations of monitored animals were plotted on a topographic map (1:24,000) with a grid by triangulating on transmitter signals from nearby known locations.

RESULTS AND DISCUSSION

Radio transmitters were implanted into four large male snakes, each measuring more than 2 m in length and weighing over 1.3 kg (Table 1). Snakes #2, #3 and #4 were released at the Tarague Beach study site while Snake #1 was released at Northwest Field. A total of 33 radio fixes were made in the study. Snakes were tracked for an average period of 13 days (range=2-24) each with a mean of 8.3 radio locations (range=3-15) obtained per animal and a mean of 1.6 days occurring between locations. Snakes #1 and #3 were tracked until they were preyed upon by monitor lizards (Varanus indicus) while Snakes #2 and #4 were followed until their radio signals were lost.

After the first day following their release, snakes generally moved short distances between radio locations. The distances between consecutive locations averaged 58.7 m (SD=110.9; n=28) with 86% of these movements being less than 100 m (Table 2). The greatest recorded distances between consecutive locations were made by Snake #4 during a 4-day period. After remaining in a small area for 20 days, it suddenly moved 430 m in one 2-day period, 410 m on a third night, and 190 m on a fourth night (Figure 1). The animal's signal was lost after this, an indication that Snake #4 made further long movements and traveled out of the study area. Other marked snakes moved shorter distances while they were monitored (Figure 2).

Table 1. Summary of data for radio-tagged brown tree snakes released in northern Guam in 1984.

Snake No.	Total length (m)	Body wt (kg)	Release date	Release site	No. days tracked	No. radio fixes	Remarks
1	2.31	1.75	16 July	Northwest Field	2	3	Killed by monitor lizard on 18 Oct.
2	2.43	1.89	24 July	Tarague	14	6	Radio signal lost on 7 August. Fate of animal unknown.
3	2.16	1.34	18 Sept	Tarague	12	9	Found dead on 1 Oct. Evidence indicated that the animal had been killed by a monitor lizard on 30 Sept.
4	2.25	1.44	16 Oct	Tarague	24	15	Radio signal lost on 10 Nov. Fate of animal unknown.

Table 2. Distances traveled between consecutive radio locations (n=28) by four tagged Boiga irregularis in northern Guam.

	Distanced traveled (m)				
	0	1-10	11-100	101-200	≥200
number	8	6	10	2	2
% of total	28.6	21.4	35.7	7.1	7.1

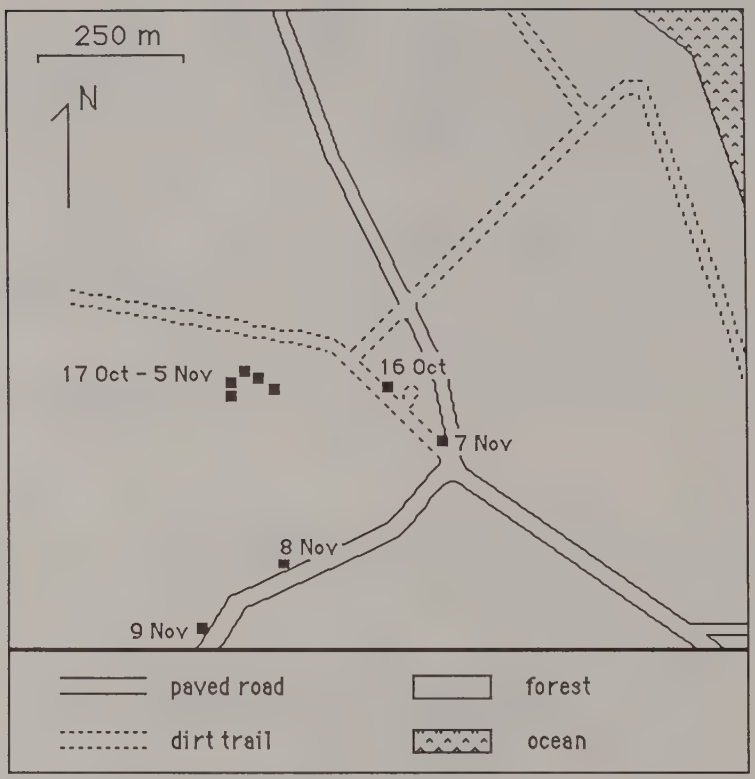

Figure 1. Movements of Snake #4 which was tracked from 16 October to 9 November 1984.

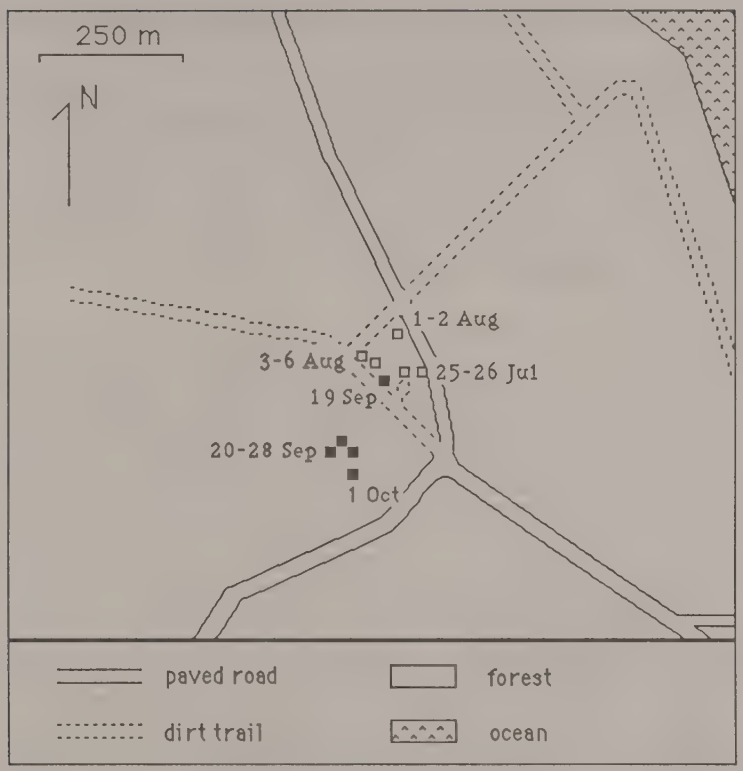

Figure 2. Movements of Snake #2 (open squares), which was tracked from 25 July to 6 August 1984, and Snake #3 (closed squares), which was tracked from 19 September to 1 October 1984.

Most radio fixes of instrumented snakes were made in daylight. In 27 (93%) of 29 daylight locations, snakes were found to be inactive, with activity undetermined at the remaining two locations (Table 3). Snakes were also inactive during each of two radio fixes made at night.

Instrumented snakes used a wide variety of resting sites during this study. At 31 locations, snakes were found at an average height of 3.1 m (SD=2.86; range=0-9), with 74% of the locations being arboreal in vegetation and 26% being terrestrial (Table 4). Twenty-three percent of all locations occurred at heights of 1-3 m, 32% occurred at 3-5 m, and 19% occurred at 6-9 m (Table 4). The most commonly used resting site for marked snakes occurred at heights of 4 to 9 m in the upper branches of small to medium-sized trees such Aglaia, Guamia, Premna and Neisosperma (Table 5). These sites accounted for 11 (35.5%) of 31 observations and were generally characterized by sparse to medium-dense leaf cover, thereby allowing the snakes to be readily seen by the observer. Other favored resting locations included the inside of a large hollow trunk of a downed Ficus prolixa tree that was used for seven consecutive days by Snake #4, and terrestrial sites among small Cocos seedlings and dead fronds found at the bases of mature Cocos trees (Table 5).

Snakes were visible to observers at 17 (55%) of 31 resting sites, a proportion that seemed unusually high when compared to the number of snakes that are normally encountered in limestone forest. Resting sites in small to medium-sized trees and on the ground were generally characterized by sparse to medium-dense foliage that allowed the animals to be readily observed. However, at other arboreal resting sites, such as in hollow trees, among clumps of epiphytic ferns, or in dense clumps of Flagellaria or Pandanus, snakes were frequently hidden by thick vegetation.

Seven (24%) of the 29 resting sites used by Snakes #2,#3, and #4 occurred in forest found within 5 m of a large opening, such as a road, jeep trail or cleared field. This band of habitat occupied only 3% of the 122-ha study site at Tarague Basin but was used significantly more frequently ($P<.0005$) by marked snakes than was forest found further from openings. This indicates that snakes may be reluctant to cross openings, preferring instead to travel (and eventually rest) along forested edges. Snake #4 exemplified an animal that was particularly hesitant to cross a wide opening. Over a 2-day period from 7-9 November, it was located three times and traveled 600 m in forest along the edge of a 13-m-wide paved road with grassy shoulders (Figure 1).

Two radio-equipped animals, Snakes #1 and #3, were preyed on by monitor lizards during this study. On 18 September at 1300 hrs, less than two days after its release, Snake #1 was found laying on the ground with a monitor lizard biting at its neck. The animals were 1 to 2 m away from a clump of Pandanus tectorius where Snake #1 had been located twice on the previous day. The lizard, judged to be about 1.2 m long, ran off quickly at the approach of the observers, leaving the snake behind. Examination of the snake revealed that it was still alive but that a 15-cm-long area directly behind the head had been partially eaten. A considerable amount of muscle had been removed from the sides and dorsal portion of this region. Snake #1 had suffered additional wounds including a severe bruise on the top of its head and a single bite mark in the center of its body where the monitor lizard had removed a mouth-sized piece of skin. This evidence indicated that Snake #1 may have been attacked while it was sleeping, with the monitor lizard biting it first in the back and then at the neck, perhaps to prevent itself from being bitten by the snake.

Table 3. Activity levels of four radio-tagged Boiga irregularis in northern Guam.

	No. locations	% of locations		
		inactive	active	undetermined
Day	29	93	0	7
Night	2	100	0	0

Table 4. Heights of resting sites used by four radio-tagged Boiga irregularis in northern Guam.

Snake No.	No. locations	location heights (m) ave. ht.	SD	ht. range	% of locations 0 m	1-2 m	3-5 m	6-9 m
1	2	1.0	0	1	0	100	0	0
2	6	2.7	2.34	0-6	33	0	50	17
3	8	4.4	3.07	0-8	25	0	38	38
4	15	2.8	3.02	0-9	27	33	27	13
Total	31	3.1	2.86	0-9	26	23	32	19

Table 5. Characteristics of 31 resting sites used by four radio-tagged Boiga irregularis in northern Guam.

Type of resting site	No. of locations	% of locations	Height range of snake (m)
Upper branches of small to medium-sized trees (Aglaia, Guamia, Premna, Neisosperma) with Alyxia vines sometimes present	11	35.5	4-9
Inside hollow trunks of Ficus prolixa	5	16.1	1.5
Among dead fronds and Cocos seedlings below mature Cocos trees	4	12.9	0
Among prop roots, leaf axils and dead leaves of Pandanus tectorius	2	6.5	1
Underneath small limestone boulders	2	6.5	0
Among clumps of epiphytic ferns (Microsorum, Polypodium) on the trunks of large trees (Ficus, Cocos)	2	6.5	4
In dense ground cover composed of grasses, small shrubs and dead Pandanus leaves	2	6.5	0
Among a dense clump of Flagellaria vines in a small Aglaia tree	2	6.5	3
Among dead fronds in the crown of a Cycas tree	1	3.2	3

Snake #3 was apparently killed by a monitor lizard on 30 September, 12 days after its release. When found, approximately one-third of the animal's carcass had been eaten although the entire spinal column from the neck to the end of the tail remained intact. The radio transmitter, found 3 m from the carcass, had numerous small conical tooth marks in its outer wax covering, indicating that Varanus had fed on the animal. The carcass's low state of decomposition indicated that Snake #3 had recently died, making it likely that it had been killed rather than scavenged by a monitor lizard.

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Wiles, G.J. in prep. The status of fruit bats on Guam.

Report prepared by: Gary J. Wiles.

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: E-1-1
STUDY NO.: 1
JOB NO.: 6

JOB TITLE: Impact of Avian Disease on Guam's Native Bird Populations.

PERIOD COVERED: October 1, 1984 to September 30, 1985.

SUMMARY

A study of the impact of avian disease on Guam's bird populations is in progress. Analyses of samples obtained during the August-September 1984 sentinel study were initiated by the U.S. Fish and Wildlife National Wildlife Health Lab and the Division of Aquatic and Wildlife Resources. To date, there is no evidence that infectious diseases are extirpating the native forest birds.

BACKGROUND

Guam's native birds have declined drastically in recent decades while avian populations have remained relatively stable on other nearby islands. Because of a similar decline (in terms of degree of severity) in native Hawaiian birds in which disease was implicated (Warner 1968, van Riper et al. 1982), introduced diseases were suggested as a possible cause of Guam's bird decline.

Between 1982-1984, a variety of birds on Guam were surveyed for diseases and a sentinel study exposing birds to potential disease vectors in the forests of northern Guam was conducted in collaboration with the U.S. Fish and Wildlife National Wildlife Health Lab (NWHL).

OBJECTIVE

To determine the presence and impact of avian disease on Guam's bird populations.

PROCEDURES

1. Bacterial, viral, tissue, and serum samples obtained during the disease studies were sent to the NWHL for diagnostic examination. Both NWHL and DAWR analyzed blood slides.

RESULTS

Disease results to date are summarized in Savidge (1986). The survey has revealed no evidence that disease was involved in the decline of the forest species. No viruses were isolated, and bacteriological tests disclosed no consistent pathogens. No haematozoans were observed in blood slides, and in general, native forest birds were free of infectious diseases.

There was no significant difference in mortality between protected and nonprotected sentinels. Many of the canaries and white-eyes that received dexamethasone died due to a variety of causes, but no consistent significant diseases were detected. Seven chickens developed avian pox, but none of the other species of birds was affected.

In June 1984, DAWR biologist, J. Savidge, spent two weeks at an avian blood parasite identification workshop at the University of Florida, Gainsville.

RECOMMENDATIONS

1. NWHL should finish analyzing all disease samples obtained during the sentinel study and DAWR, in cooperation with NWHL, should submit a final report.

2. Vanikoro Swiftlets should be sampled for disease. This species, a cave nester, declined in a dissimular pattern to the forest birds.

LITERATURE CITED

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Report prepared by: Julie A. Savidge

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: E-1-1
STUDY NO.: 4
JOB NO.: 1

JOB TITLE: Captive Breeding of Endangered Native Birds.

PERIOD COVERED: October 1, 1984 to September 30, 1985.

SUMMARY

Nine Micronesian Kingfishers and twelve Guam Rails were captured on Guam and transported to the Phildelphia Zoo in November 1984. During the summer of 1985, kingfishers were hatched for the first time in captivity at three mainland zoos. Thirteen rails were hatched at the Guam Division of Aquatic and Wildlife Resources rail facility. In July, 1985, efforts to capture additional rails were suspended because virtually no rails could be found in the wild to capture. By September 30,1985, there were 26 kingfishers in captivity at mainland zoos and 56 rails in captivity both on Guam and at mainland zoos.

BACKGROUND

Since the creation in 1960 of the Guam Division of Aquatic and Wildlife Resources (GDAWR), census data from roadside counts, station counts, and transect counts have documented the reduction in range and numbers of the Guam Rail and other native birds (GDAWR, 1974-1984; Jenkins, 1979,1983; Engbring, 1984). Most native forest birds are now restricted primarily to Northwest Field and Conventional Weapons Storage Area and surrounding cliffline areas on Andersen Air Force Base (AAFB) in Northern Guam. By 1984, the Guam Rail population numbered less than 20 and was restricted to the flightline area on AAFB.

Predation by the brown tree snake, *(Boiga irregularis)* is believed to be the major factor contributing to recent declines in native bird populations (GDAWR, 1984).

A captive breeding program aimed at preserving in captivity Guam's endemic species and subspecies of native forest birds was begun in late 1983 in cooperation with the American Association of Zoological Parks and Aquariums and several of it's member zoos (GDAWR, 1983). Efforts at captive breeding the Bridled White-eye, Rufous Fantail and the Guam Flycatcher were abandoned in 1984 due to their disappearence in the wild (GAWR, 1984). In January 1984, six pairs of Micronesian Kingfishers were transported to the Philadelphia Zoo after being captured on Guam in the fall of 1983. Some were distributed to the Bronx Zoo in New York City and the Conservation and Research Center (CRC) of the National Zoological Park, Front Royal, Virginia. By September 1984, none had bred in captivity. Guam Rails were first brought into captivity in 1983 on Guam and bred at the GAWR's rail facility in the spring of 1984. By September, 1984, a total of 28 rails were in captivity, with 21 on Guam and seven at zoos in the states.

OBJECTIVES

Implement a captive breeding program for the Guam Rail and other endangered endemic birds by setting up facilities on Guam and at zoos on the mainland with the assistance of the American Association of Zoological Parks and Aquariums. Develop techniques for release of captive reared birds in the wild once the factors responsible for their decline have been identified and controlled.

PROCEDURES

1. Continue to consult with recognized authorities regarding captive breeding methodology, facility designs, and captive population management techniques.

2. Continue the development of a cooperative captive breeding program for the Guam Rail and Micronesian Kingfisher with the AAZPA and it's member zoos.

3. Begin development of capture and captive breeding techniques for the Mariana Crow.

4. Develop techniques for the successful release of captive-reared birds in the wild once the factors responsible for their decline have been controlled.

5. Upgrade and enlarge the Guam Rail breeding facility at GAWR office in Mangilao to allow up to 50 birds to be held in captivity.

8. Develop techniques for successful release of captive reared birds into the wild.

9. Continue to develop techniques for successful release of captive reared birds into the wild.

10. Conduct study into the breeding biology in the field on Guam of birds that are to be captive bred.

11. Consult and coordinate with U.S. Fish and Wildlife Service, U.S. Department of Agriculture, and other government agencies with jurisdiction over the interstate movement and captive maintenance of widlife. Acquire all necessary local and federal permits.

RESULTS

From September to November,1984, nine Micronesian Kingfishers were captured in the Jinapsan Basin and Northwest Field area of AAFB in Northern Guam. They were transported to the Philadelphia Zoo on November 28, 1984 by Continental Airlines as a donation. The first kingfisher eggs were hatched in captivity at the Bronx Zoo of the New York Zoological Society in May, 1985. The eggs were artificially incubated after the parents stopped incubating them and the chicks were hand-reared. On August 1,1985,the first fledging of kingfisher chicks that were hatched by their parents occurred at the Philadelphia Zoo. On August 3,1985 the first kingfisher was hatched at the CRC. In addition to the three zoos mentioned above, kingfishers are also in captivity at the Denver,

St. Louis and San Antonio zoos. As of September 30,1985, there were 26 Kingfishers in captivitiy both on Guam and at mainland zoos.

From June to August, 1984, Sam Marshall, Research Associate of the New York Zoological Society studied the breeding biology of the Micronesian Kingfisher in it's last known habitat on AAFB in cooperation with GAWR staff. A survey done during this period located six pairs of kingfishers and several additional apparently unmated males in Northwest Field and the Conventional Weapons Storage Area on AAFB.

On November 28,1985, 12 rails were transported to the Philadelphia Zoo and then distributed to the Bronx Zoo and the CRC. Rails were breeding at both locations during the year. Beginning in January, 1985 rail drives resumed on the flightline area of AAFB with little success due to the rapidly declining population. One rail was captured on March 1, 1985. Capture attempts were suspended on 7/1/85 when a census revealed only one remaining rail in an area unsuitable for capturing.

At the GDAWR's rail facility on Guam, 13 rails were hatched from October 1, 1985 to September 30,1985. Five rails died, three apparently from stress associated with capture or transfer, one was killed by a cagemate and the other died of undetermined causes. On September 30,1985 there were 20 rails at the GDAWR facility, 25 rails at the CRC and 15 rails at the Bronx Zoo for a total of 60 rails in captivity.

In early September, 1985, Gary Michael, Aviculturist at the Philadelphia Zoo, arrived on Guam to begin a three month study of the breeding biology of the Mariana Crow in it's last remaining habitat on AAFB. The GAWR is planning to capture one pair of crows in order to develop captive breeding techniques at the Philadelphia Zoo.

RECOMMENDATIONS

1. Continue to consult with recognized authorities regarding captive breeding methodology, facility design, and captive population management techniques.

2. Continue development of a cooperative captive breeding program for the Guam Rail and Micronesian Kingfisher with the AAZPA and it's member zoos.

3. Continue development of captive breeding techniques for the Marianas Crow in cooperation with the AAZPA.

4. Upgrade and enlarge the Guam Rail breeding facility at GDAWR office in Mangilao to allow up to 50 birds to be held in capitvity.

5. Continue to develop capture techniques for the Guam Rail and other forest birds as needed.

6. Seek funding for transport of birds to zoos for captive breeding from conservation groups and other private sources.

7. Continue study of breeding biology in the field on Guam of birds that are to to be captive bred.

8. Develop techniques for release of captive reared birds into the wild.

LITERATURE CITED

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Guam Divison of Aquatic and Wildlife Resources, 1974-1983, Job Progress Reports - Federal Aid to Fish and Wildlife Restoration. Dept. of Agriculture, Guam.

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Report prepared by: Robert E. Beck, Jr.

LAW ENFORCEMENT
Funding Source: Government of Guam

LAW ENFORCEMENT

A total of twenty persons were arrested and charged for the offense of illegal hunting by the Conservation Officers in fiscal year 1985. Five of these persons were intercepted by military security personnel and were referred to the Conservation Officers who then subsequently charged them for violating Fish and Game Laws. The other fifteen individuals were intercepted by the Conservation Officers during their routine day and night patrol. One individual has already pleaded guilty and the rest are awaiting prosecution by the Attorney General.

Two 1983 Toyota 4x4 pickup trucks were used to transport game carcasses by some of the individuals charged above and were thereby confiscated as part of the evidence. One truck has already been legally ordered by the court to be forfeited to the Department of Agriculture for its disposition. The other truck is awaiting forfeiture proceedings.

Additionally, as ordered by the court, the Department has also received permanent custody of a 12 foot boat with a 35 horse power outboard engine. This order resulted from an illegal fishing case (dynamiting) which was made by the Conservation Officers during last fiscal year, 1984.

Although there were no illegal fishing cases this year, there were however illegal fishing incidents (dynamiting and poisoning) recorded by the Conservation Officers. These incidents were reported by citizens and then were investigated by the Conservation Officers. By the time the Conservation Officers arrived at the scene to investigate, the violators would no longer be in the area. There were several other illegal hunting and illegal fishing incidents which were investigated by the Conservation Officers but weren't made into cases because of insufficient evidence or because warnings were issued as it was thought to be more beneficial at the time. Among the incidents investigated, are illegal spotlighting; gunshots; dynamiting; poisoning; taking undersize lobsters; turtle hunting; abandoned gill net; selling undersize coconut crabs; and selling suspected local fruit bats.

One Conservation Officer was assaulted with a deadly weapon (shotgun) when he investigated what he suspected was an illegal hunting activity at Naval Magazine. He didn't have sufficient evidence to make an illegal hunting arrest but filed an assault complaint and the suspect was arrested by a Guam Police Officer.